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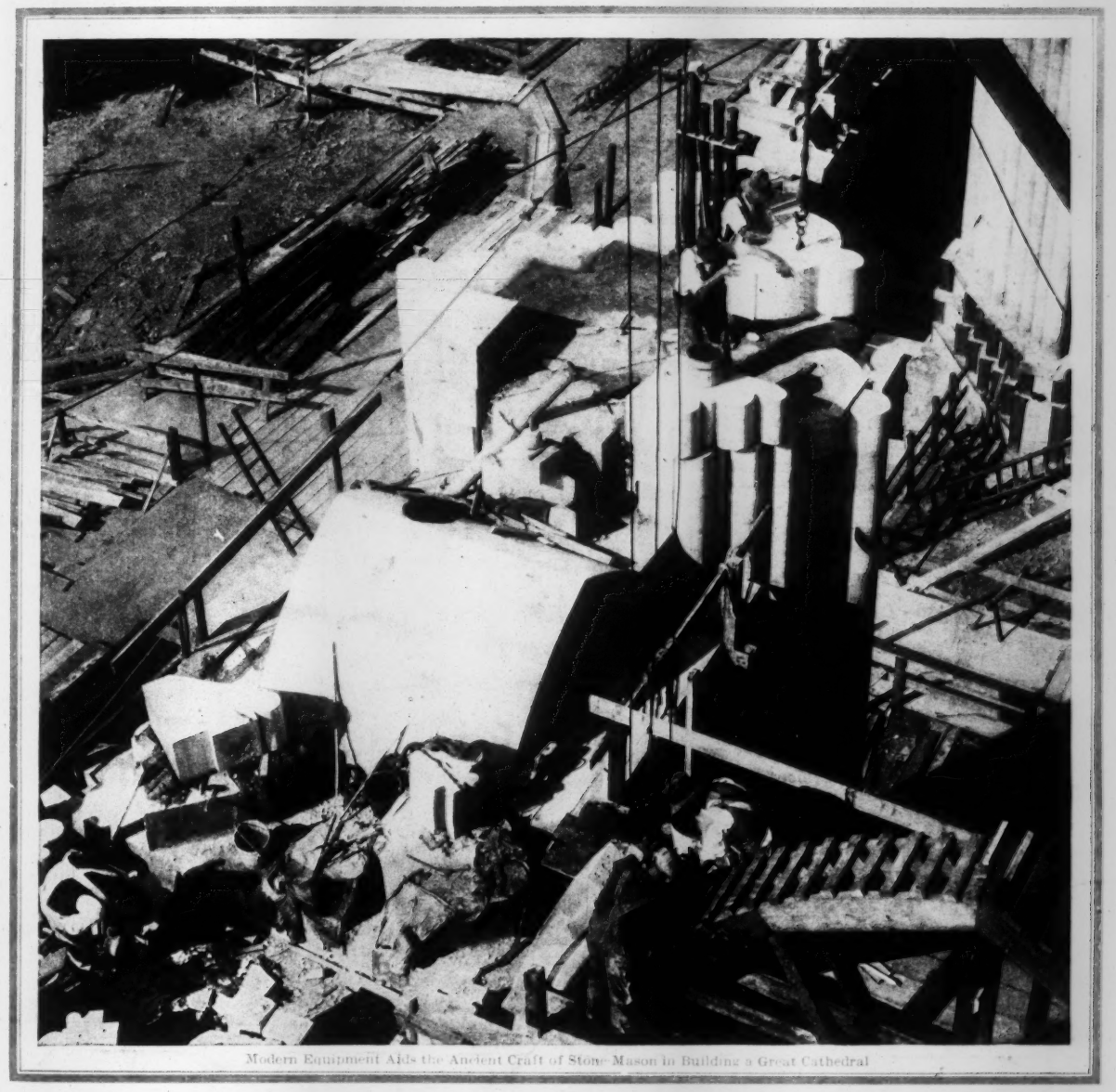

Modern Equipment Aids the Ancient Craft of Stone Mason in Building a Great Cathedral

Vaulted Roof of Cut Stone Built from Steel Staging—Motor Vehicle Registration Based on Average Income, by N. W. Dougherty—Missouri River Regulation at Lexington Bridge, by L. J. Sverdrup—Erecting a Self-Anchored Suspension Bridge, by V. R. Covell—Ore Dock Reconstruction in Steel and Concrete—Staff Report on the New England Water Works Convention

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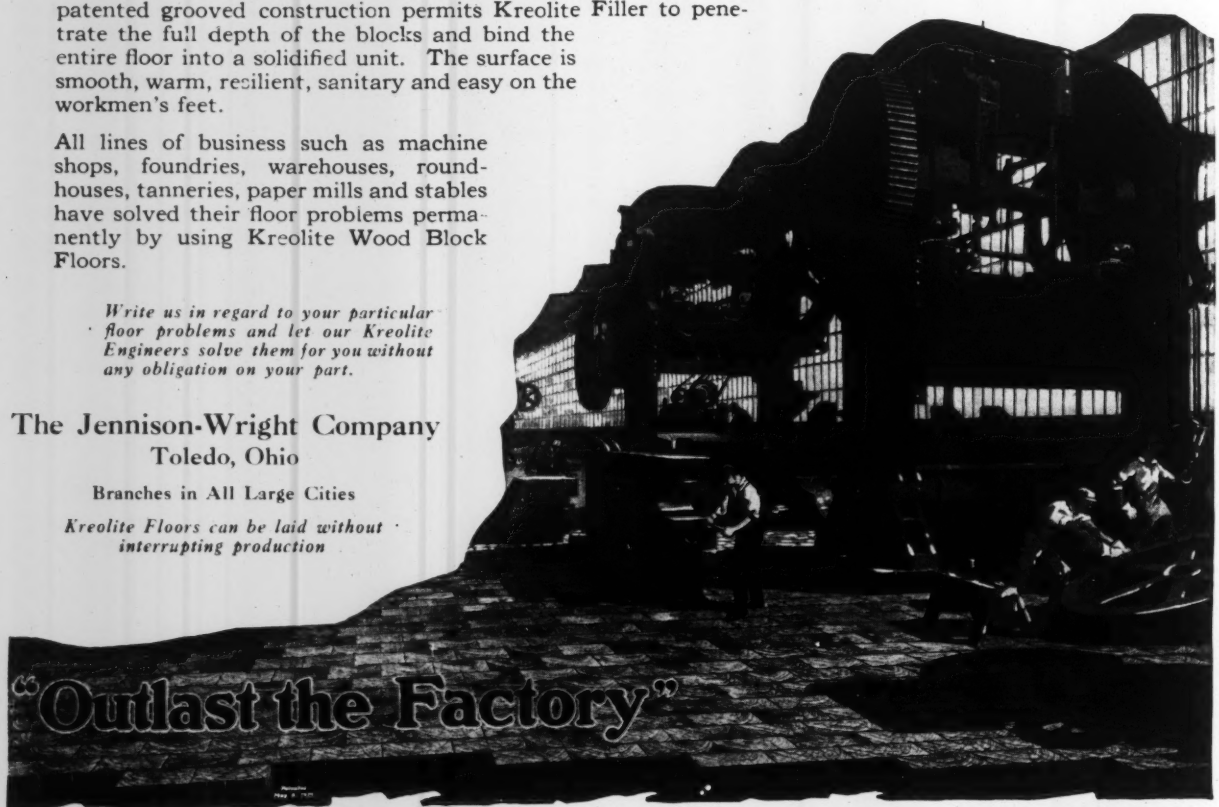

WOOD BLOCK FLOORS

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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A Gigantic Test

AS THIS is written only the most vague reports are coming in from wind-swept Florida, but they indicate a catastrophe there of first magnitude. Hurricanes, like earthquakes, are unpreventable. The best man can do is to accommodate himself to them. It remains to be seen whether in the rush of the boom construction period that south Florida has been experiencing structures were built sufficiently staunch to withstand the tremendous forces that the Caribbean shores must expect. Engineers and builders contributed about the only reality to what for some years has been a most unreal manifestation of human effort. We can but hope that their contribution stood up under the test.

Eating and Keeping One's Cake

LAST week the Board of Transportation of the city of New York announced that no foreign steel would be used in the new subways. Such steel can be bought considerably cheaper than can the American product and the contractors want to use it. Naturally if they did use it, the saving would accrue to the people of the city who are paying for the subways. But the Board, while making some tenuous claims as to superior qualities of American steel and the difficulties of inspection of foreign products, gives its real reason when it says that it "does not wish to unnecessarily invite foreign made steel here." The dilemma that confronts the Board is a real one. It is confronting a number of other American public bodies and will continue to do so for some time. Europe can produce a number of things more cheaply than can the United States. If she is to pay us the money she owes us she will have to sell these things here. If we will not buy them we must expect difficulty in collecting our debts. World financial dominance means world competition. We cannot have our cake and eat it too. The nation strives to protect its industries by a tariff wall. If the minor governmental bodies set up further barriers the nation will find itself more and more embarrassed when it comes to discuss debt settlements.

Through Route Detour Marking

HIGHWAY engineers are making notable advances in the thoroughness of detour marking. The principle that the road is a medium for travel and that there is an obligation to facilitate that travel is perfectly well understood and it is rare today that the roadbuilder assumes that the construction of a road means that communication must cease along that route. But it does seem from traveling around the country that there is not enough consideration given in marking detours for the through tourist. A frequent experience for the motorist on an unfamiliar main road is to run into a piece of construction with a by-pass detour that takes him over a poor, just passable, back road. Later examination of his map shows him that four or five miles back he came to a cross-road where, had he known of the coming detour, he could have taken an alternative route which while neither as smooth or as short as the main route would have been measurably superior in both respects to the main route plus the detour he was forced to make. A proper sign at this cross-road would have saved his car and his temper, but the engineer on the road construction did not choose to look that far back into the travel desires of the users of his road. A thorough consideration of the road user would require just this kind of examination and the kind of detour marking that the examination would reveal as desirable.

More On Direction Signs

ANOTHER obligation upon the engineer in placing signs on roads is to see that they are readable. This not only means that they should be placed where the driver of a car can see them, both by day and in the light of the head lamps, but that there should be some effort to keep the sign area free from any but necessary directions. One horrible example was recently seen, where there was placed just such a forewarning detour sign as is suggested in the preceding note. This sign was completely missed by several successive tourists because at the same corner not only was there the usual group of direction signs but a choice collection of advertising signs directing the traveler to about every hotel, inn, and garage in the next twenty miles. A driver's eye can comprehend only just so much. It should not be burdened with disturbing signs at those places where he may expect to receive necessary directions.

Twentieth Century Cathedral Building

STRUCTURALLY the great New York cathedral, described in this issue is medieval. It is true masonry—not concrete and tile and steel; arch and dome, wall and tower, buttress and pillar are cut and carved stone. But in its construction the note of modernity is struck. Where in the old cathedrals the stone was shaped by the mallet and chisel of the mason it is now made ready largely by the stone dressing machine and the pneumatic tool. The former mazes of timber staging and centers are replaced by a comparatively simple supporting structure and working platform of steelwork. The electric elevator and derrick now do the work of hand winches and many human carriers. Today the old methods would have put the cost beyond count. Even by the measure of modern methods and machines, here was a difficult construction task. There are repeated circumstances, as may be observed on the cathedral work, in laying fine architectural stone masonry where old ways and tools cannot

be bettered. No power hoist can surpass the hand winch in convenience and precision in lining in, for example, the stones of the clustered columnar piers shown in the cover illustration. But without modern methods the practicability of such a structure as the cathedral of St. John the Divine would be doubtful. Out of them come speed and safety and a limited need of workmen and out of this gain come economy and therefrom the possibility of reproducing a medieval type structure at present-day prices and wages.

"Period Efficiency" for Water Wheels

WHEN the requirements for a new hydro-electric plant are announced various manufacturers submit proposals and the purchaser undertakes to select the type and pattern of the turbine which he believes best for his needs, all things considered. Price is usually the first consideration and next comes "efficiency." The ratio of input to output at a given instant under test conditions is usually satisfactory evidence of what can be gotten out of the machine for a given input. Hydraulic turbines, however, like other parts of the plant, are subject to troubles that interrupt operation. Vibration, pitting or cracking of vanes, outage time for the renewal of seal rings or other worn parts may materially decrease the total output of the plant in a period of months or years. The tendency in recent years has been to build reaction turbines for higher heads, higher draft-tube vacuums and higher specific speeds and with these more exacting conditions come new dangers to menace dependability. The purchaser should not take too much for granted in the matter of reliability; materials of construction, ruggedness and accuracy of shopwork might not show up in a test of the input-output ratio but are vital factors in long service. In a plant where continuous service is desired, a unit out of service for repairs several days a year warrants a lower "period efficiency" rating than a turbine not able to develop quite as much power for a given input but which could be depended upon for longer uninterrupted service. The instantaneous ratio of input to output may be the only practicable means of arriving at a tangible efficiency rating for comparative purposes but in the last analysis it is not the showing under test conditions so much as long continued performance that is the true basis for rating the efficiency of a hydraulic turbine.

Where Not to Bathe

STATE CONTROL of bathing in waters used for public supply varies in this country from none whatever to well nigh if not quite absolute prohibition in some states. Last week a delegation, chiefly from Jersey City, waited on the New Jersey State Board of Health and strenuously urged prohibitory regulations as an amendment to the State Sanitary Code. In Illinois, a few years ago, such bathing was prohibited but only within a comparatively short distance of a water-works intake—a quarter mile or so. Of the six New England states, according to a paper read before the New England Water Works Association last week, five prohibit such bathing, while in New Hampshire it is subject to control, perhaps city by city, by the State Board of Health. Like most other dangerous things needing public control the dangers in this case are relative and attempts to control them should be varied accordingly, as also with due regard to other interests, lest extreme measures, which in some cases may protect but a few against small risks, deprive many from great benefits. Outdoor bathing is unquestionably a healthful recreation, which should be encouraged under reasonable conditions. Numbers of bathers, volumes of diluting water, nearness of bathing places to the water intakes, both in point of feet or miles or days or months required for the water to get to the intakes, are all factors that should be considered, as well as whether the water in question is, or if it is not, ought to be, filtered or chlorinated or both before going to the consumers. Unquestionable authority to prevent bathing under such conditions as will menace its water supply should be lodged in the public authorities of all communities in every state, subject to supervisory control by some state authority. The predatory public should be told, and told plainly and with police powers back of the telling, where not to bathe. Enforcement of such rules should rest with the local authorities, backed in extreme cases by the state through its departments of health and justice.

Water-Works Society Co-operation

JUST WHAT the retiring president of the New England Water-Works Association had in mind last week when at the very close of a short presidential address he suggested the appointment of a committee to consider co-operation with the American Water Works Association, he neither disclosed or hinted. Action on the suggestion might lead to changes full of meaning to both organizations. Far-sighted members of the two associations may see ultimate consolidation in the suggestion. Time was when the New England association led the American in point of technical deliberations and equalled if not slightly exceeded it in members, many of whom were outside New England. Able leadership has taken the American association far out of the slough into which it once sank. The New England association still has many members scattered through the United States, Canada and foreign countries, including some of the most notable engineers, chemists and bacteriologists of the day. Besides its notable annual conventions it keeps up a practice of decades in holding luncheon-meetings in Boston through the cooler part of the year, with a June get-together outing in addition. Just how much the New England association would lose in becoming a section of its now much larger sister organization is a matter subject to differences of opinion. In age the two associations are close together, the American having held its 46th annual convention last June and the New England its 45th last week. There have already been a few successful attempts at co-operation. The committee on co-operation suggested by Mr. Bristol might well be formed as a joint committee of the two bodies. If that were done the two associations might unite in a jubilee celebration of their fiftieth anniversaries, which will fall together, and then or later adopt some form of merger, the New England association continuing its sectional activities and influence through a proper organization for that purpose. If the Canadian Water Works Association would join in the merger, preserving also its sectional function, it would be welcomed by both associations this side of the border. Such a joining of forces would add to the solidarity of the water-works interests of the continent.

Railway Recruits

FROM the survey of the demands for instruction in the field of transportation made by Yale University, which was reviewed in the Engineering Literature section of this journal last week, it would appear that railroad officials have little sympathy with any attempt of the college to prepare young men to follow their footsteps. There was the usual suggestion that the best the college or technical school could do was to make thorough the instruction in the "fundamentals" with the also usual vagueness as to just what these "fundamentals" are and how they should be taught. But beyond this the impression gained by the exceptionally thorough investigators was that the railroad man regards his business as so detailed and unique that preliminary training can not be specialized and that nothing short of the hard road of experience, with frequent stops, will lead the traveler to the desired end. And there were more than a few who seemed to feel that college training might be more a hindrance than a help.

Those whose observation has been longer though not so intensive as that reported in this survey will find here a familiar state of mind. Railroading partakes fully as much of the nature of a guild as it does of a profession. Its members are drafted while young and they progress by slow stages through the successive ranks. After they have attained any position of responsibility they rarely leave to engage in other work and the higher places are rarely filled from the outside. There result therefore all the undoubted advantages of a closed trade, that is a complete knowledge of details and a comprehensive code of practice, but there result, too, the obvious disadvantages of a narrowness of outlook and a too great reverence for precedent and procedure, disadvantages which are found also in the military organization, which in some ways the railway organization resembles.

To attempt, therefore, to prepare a college course which will facilitate a man's progress in a business which sets so high a premium on its own regimen of training is a difficult task. Especially is this so because the usual assumption has been that the proper training for a railroad man is basically an engineering one, and because the engineering branches of railroading are peculiarly alive to this sense of their own individuality.

It will not be denied that railroad engineering is peculiar to itself. The preparation and maintenance of the motive power, the way and the structures are interwoven with the operation of the trains which is the purpose of the system. Everything that is done on way and structure, therefore, must be subordinate to operation, a means to an end, instead of being as in so much else of engineering an end in itself. Organization demands, almost insufferable routine and detail, must always govern the railroad engineer's operations. He is one cog in a huge machine, and because that cog is in the parts farthest removed from production, it must function with the least tendency toward independence.

Further than that, the engineer in the railroad is, by virtue of the fundamental character of his work, the farthest removed from contact with the user of the product of his machine. The railroads in general are learning that because they serve the public they must make some effort to please the public. Their selling organizations, both freight and passenger, are now doing everything they can toward that end. This philosophy has not penetrated far into the engineering fabric of the railroads. The engineers still feel themselves the servants of a corporation rather than the servants of the people that corporation in its turn serves. Enter the average railway engineering office and note the unconcern displayed as to your wants. The impression is unavoidable that you are interfering with the normal functions of a private business.

This attitude of the engineers is merely a symbol of their conception of their function. It is perhaps unavoidable, perhaps necessary, we will not debate that, but it may account for the opinions on education the Yale investigators found. Those railway leaders who just "went to college" and who succeed in rising to high place are forgotten in any analysis of the value of education for the railway leader. It is only those trained as engineers that are weighed in the balance. With one or two minor exceptions, the present attempts to provide collegiate training looking toward the railway as a career have been in the engineering schools and have emphasized the engineering details of railroading. The graduates from such courses therefore enter the railroad service through the engineering branch, though they may have hope of rising eventually to executive direction, which means of course that they must in time go through the several other branches. But they start as engineers and they are subjected to the discipline and surveillance of their superior engineers.

And the railroad engineer is a guildsman. He has learned his trade by the slow acceptance of hard knocks. Long ago he himself may have been an engineering student. He learned then many things that he has since forgotten; possibly he set then the foundation for the superstructure of detail that now encloses him but the foundation building was back in the past and the substructure is in the continuing present. He inevitably stresses that present and depreciates the forgotten past. He has built up in the century that his craft has existed a theory of its uniqueness in engineering endeavor. He is the most class conscious of all engineers. This class consciousness, however justified, soon affects the newcomer and in short time he himself becomes as his superior, suspicious of the value of preliminary training, and if by virtue of ability he does rise to executive position he is apt to share the opinion of his non-engineering fellow executives that the way to railway eminence is but little smoothed by collegiate technical preparation.

No wonder, then, that it is difficult for the colleges to decide how to prepare a man for a railway career. The railway men themselves do not know what they want and however sympathetic they may really want to be toward others' plans for college training they have a generation-old feeling that after all such training doesn't make much difference provided the candidate is of the right stuff and willing to work through the grind of service. It would be a hardy youngster who, studying the conditions reported by the Yale experts, felt it worth while to spend four years in a college course in order to prepare himself better to rise in railway service. And yet it cannot be that railroading is so different from the rest of industry as railroad men would appear to believe. Few doubt the value of collegiate training, and especially of engineering training, in general industry. Why not for railroading? Is it the fault of the railroad men themselves?

Vaulted Roof of Cut Stone Built from Steel Staging

Large Erection Structure of Steel Devised by Contractor to Support Derricks and Centering for Placing 90,000 Tons of Masonry in St. John's Cathedral, New York City

STEEL staging and centers are used in a notable manner in constructing the vaulted roof of cut stone rising a hundred feet above the floor of the nave of the Cathedral of St. John the Divine in New York. This church which has been in the slow course of construction a third of a century is shown in skeleton plan by Fig. 1.

At present there are completed the crossing, choir, apse and seven chapels, except the great tower which will surmount the crossing; and the nave, which later will have two façade towers, is going up on a foundation and over a crypt completed some years ago. Specifically the nave construction now under way comprises the side walls, four rows of seven piers delineating the aisles and nave, and more notably, because of its construction difficulty, the Gothic-arch stone roofs of aisles and nave proper.

Structure to be Built—The floor plan and a cross-section of the nave are shown by Fig. 4. Including the north and south aisles and the north and south ambulatory aisles, the structure is 250 ft. long and 150 ft. wide. The nave proper is 55 ft. wide and is separated from the north and south aisles by three piers, 17x11 ft. in plan alternating with four 8x8-ft. piers. These piers, 14 in all, support the main vaulting of the nave, which consists of Gothic arches, some starting 98 ft. above

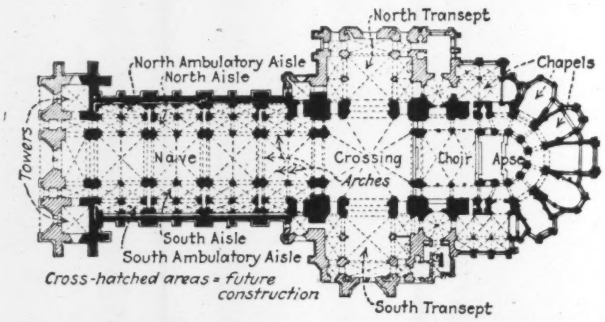


FIG. 1—FLOOR PLAN OF CATHEDRAL WHEN COMPLETED
Black areas indicate part in use or under construction; cross hatched walls and piers represent future construction. Dotted lines indicate arches in ceiling.

the nave and having a rise of 22 ft. and others starting 85 ft. above the nave floor and having a rise of 36 ft. (The nave floor is considered as El. 100 and all elevations

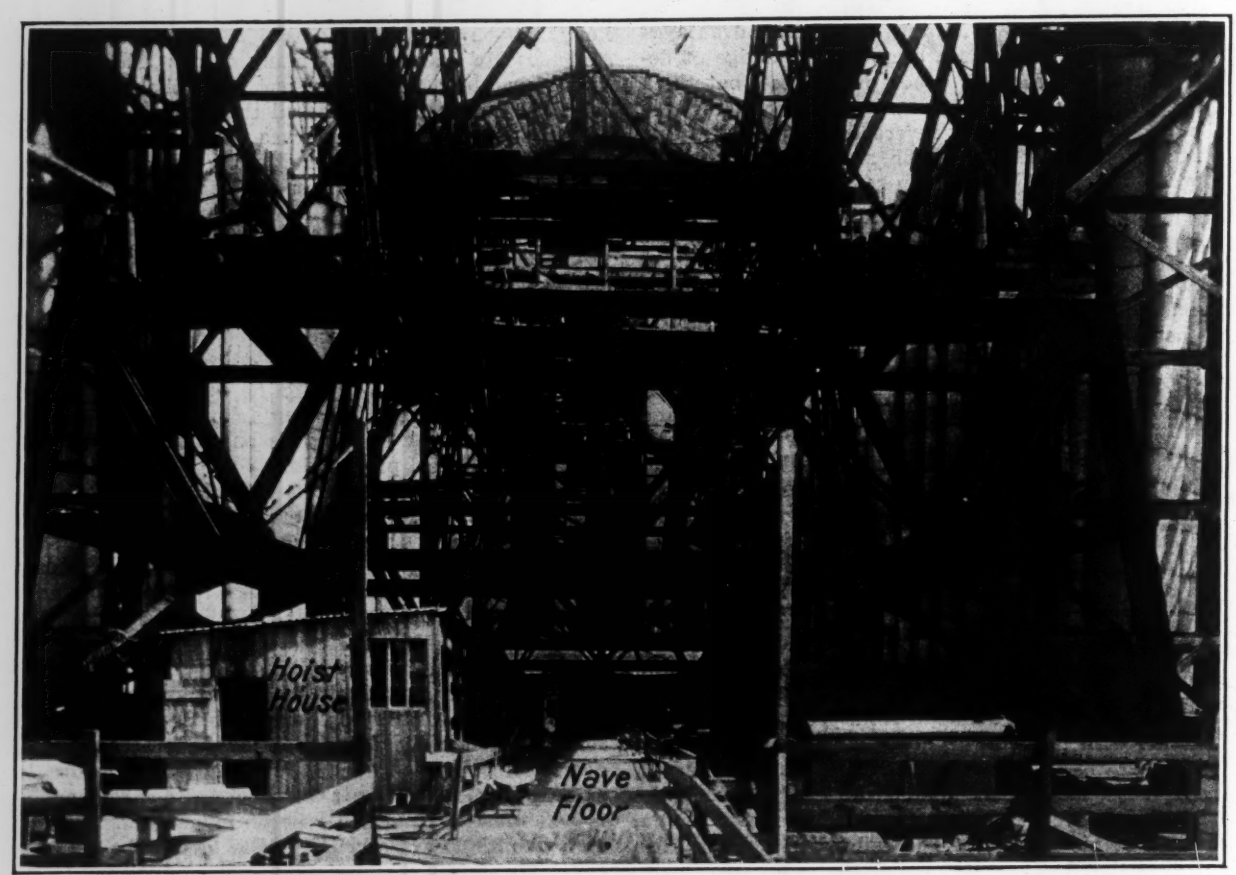
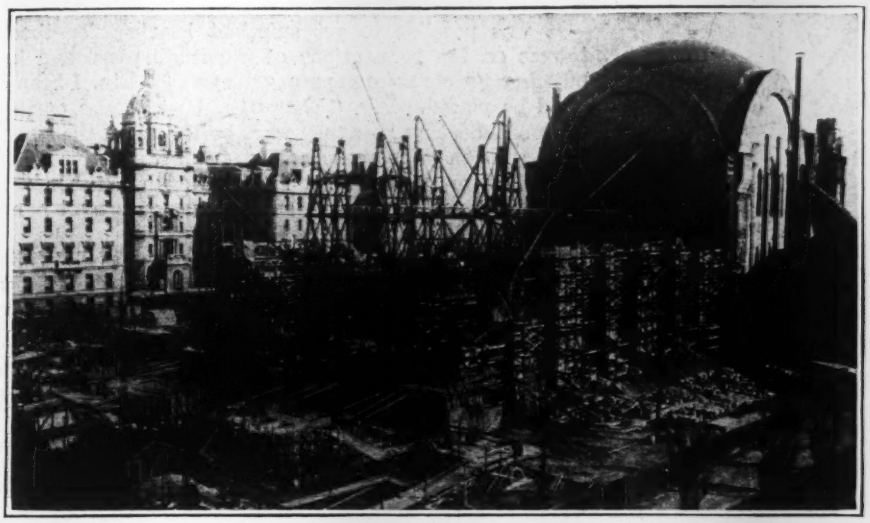


FIG. 2—ERECTION TOWER BENTS SPANNING THE NAVE FLOOR
Note the houses inclosing the electric hoists operating 20-ton derricks.

will be referred to that datum.) The largest arch weighs 250 tons. The larger piers are built with granite cores and are faced with limestone, while the smaller ones are of granite, each stone covering the entire cross-section of the pier. The height of the stones in the smaller piers varies from 14 to 24 in.

The ambulatory aisles are separated from the north and south aisles by three large piers alternating with four lesser piers of limestone and of the same dimensions as those previously mentioned. These piers, which are approximately 50 ft. high, support the walls of the cathedral that extend upward to the base of the nave vaulting at El. 198. The outside walls of the ambulatory aisles along with the buttresses form the outside walls of the cathedral.



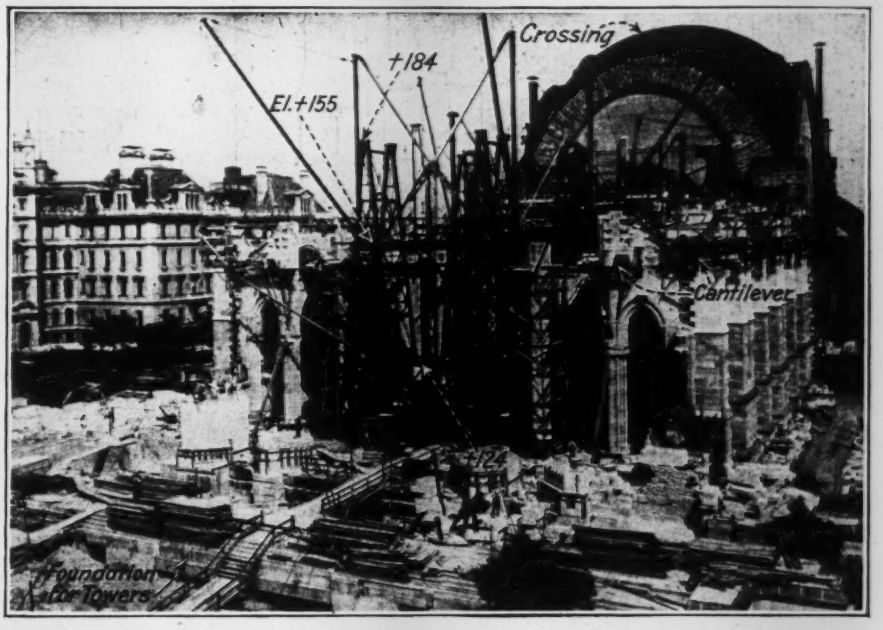


FIG. 3—CONSTRUCTION PROGRESS ON CATHEDRAL OF ST. JOHN

Note that most of the wooden staging shown in the upper picture has been removed in the right-hand picture and the remainder supported on cantilevers from the steel structure.

In construction then, the major problems that the contractor had to solve were: (1) Reduction to a minimum of fire hazard in scaffolding, (2) centering 250-ton stone arches 120 ft. (at the crown) above the floor, and (3) design of a centering system that could progressively adapt itself to an increasing height up to about 100 ft., in addition to supporting scaffolds and erection derricks.

Devising a Construction Plan—All of the piers are on concrete foundations on rock. These foundations were built about ten years ago, at which time the floor of the nave was put in place. This floor is a tile floor, of ample strength for its use as a floor, but wholly inadequate to carry falsework and centering for the roof arches. Furthermore, the tile slab, being cellular, could not be shored from below, since it would undoubtedly crush under any considerable load. The next possibility was to cut through the floor and impose the loads on the floor of the crypt. This plan had to be discarded because the foundation had been built without sheathing the sides of the pier holes and very extensive backfilling had therefore been necessary. It was felt that there was a dangerous possibility that this fill would settle under the loads.

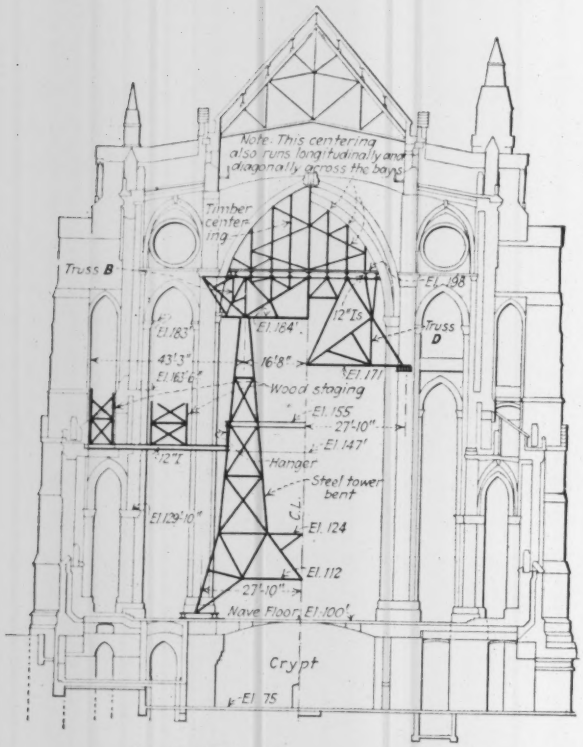
The problem then resolved itself into finding some means of spanning the nave floor and devising an unyielding support. The certain shrinkage of timber work supporting centers nearly 100 ft. above the base and the extreme fire hazard prohibited the use of wood. It was therefore decided to erect a steel structure, Fig. 4, between the interior columns, to support hoisting rigs and scaffolding and centers for erecting two lines of piers on each side, the outside walls, the buttresses, and the arch vaulting in the roof. Furthermore, it was planned to erect this steel structure only so fast as the operations developed upwards. Some wooden staging would be necessary for erecting the walls but other than that the steel structure was to be the basis of the construction plan.

The Steel Erection Structure—As noted, it was advantageous to have an erection structure that could be progressively built up as needed. This has been the plan and hardly half of the final structure is shown in place in the accompanying illustrations. All the component parts of the erection structure are indicated in place in Fig. 4. Trusses spanning between the seven

pairs of piers surmounted by a platform of steel I-beams upon which the centering for the heavy vaulting will bear, are the basic idea.

To describe the steel structure it must be noted that at El. 173 there is to be a passageway running through the large piers north to south. A grillage of I-beams will be placed in these openings as a bearing for trusses *D* whose top chord will be at El. 198 and upon which the platform will be placed. These trusses are not yet in place. On the smaller nave piers it was impossible to take a bearing since they were solid for the entire 98 ft. Steel tower bents were accordingly erected around each of these small piers to support trusses similar to those between the large piers. These towers, of which there are eight (4 pairs) are shown erected to El. 184 in Fig. 3. Trusses *B* will ultimately be placed between towers with their top chords at El. 198.

It was possible to get sufficient bearing for these towers on the foundations of the small piers and by building up concrete caps a grillage of 24-in. I-beams could be placed. Fig. 6 shows the base of one of the towers indicating how they were built around the small piers. As may be seen in Fig. 4, 12-ft. trusses with their bottom chord at El. 112 also span between the towers. Their top chords support various small hand



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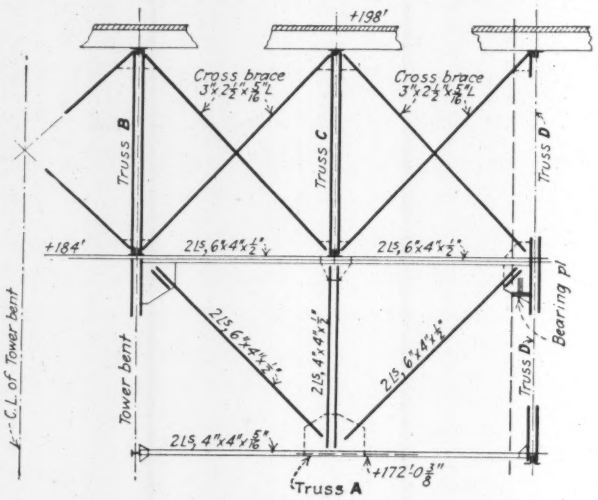

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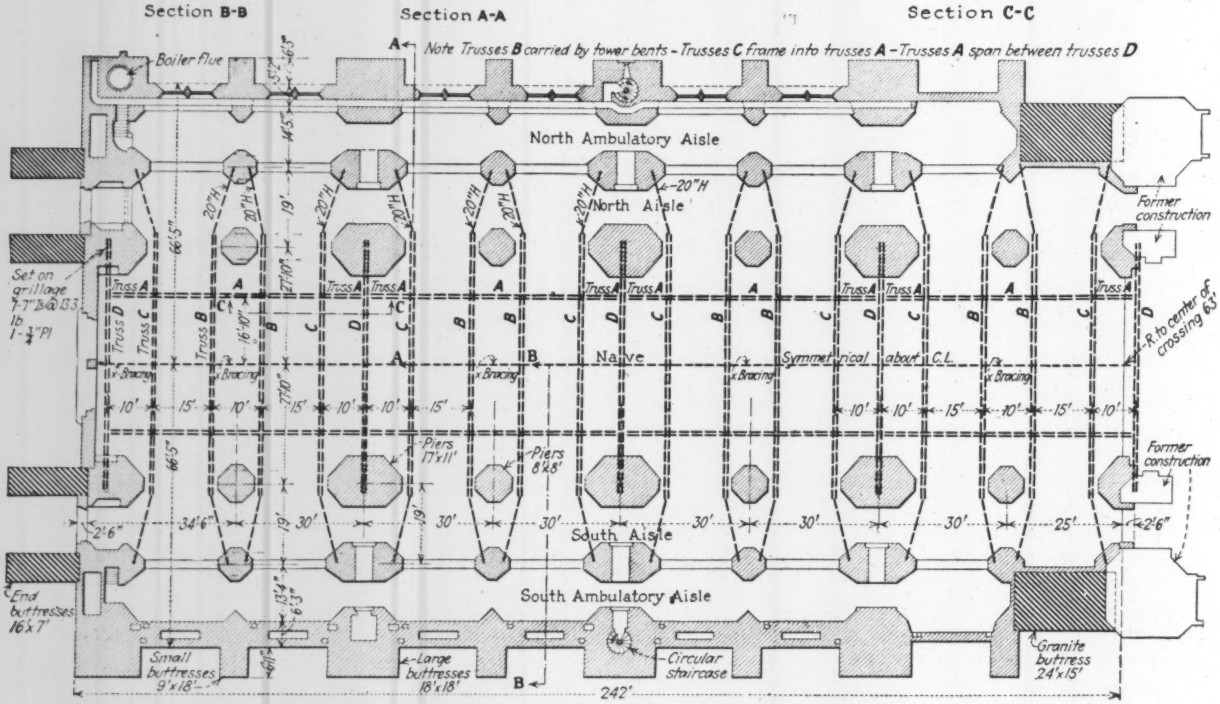


FIG. 4—PLAN AND SECTION OF NAVE OF ST. JOHN'S CATHEDRAL SHOWING LOCATION OF MEMBERS OF STEEL ERECTION STRUCTURE

derricks for placing the smaller stone. Also at El. 155, conveniently above the ambulatory aisle roof, I-beams are placed between the towers both transversely and longitudinally to provide supports for erection platforms

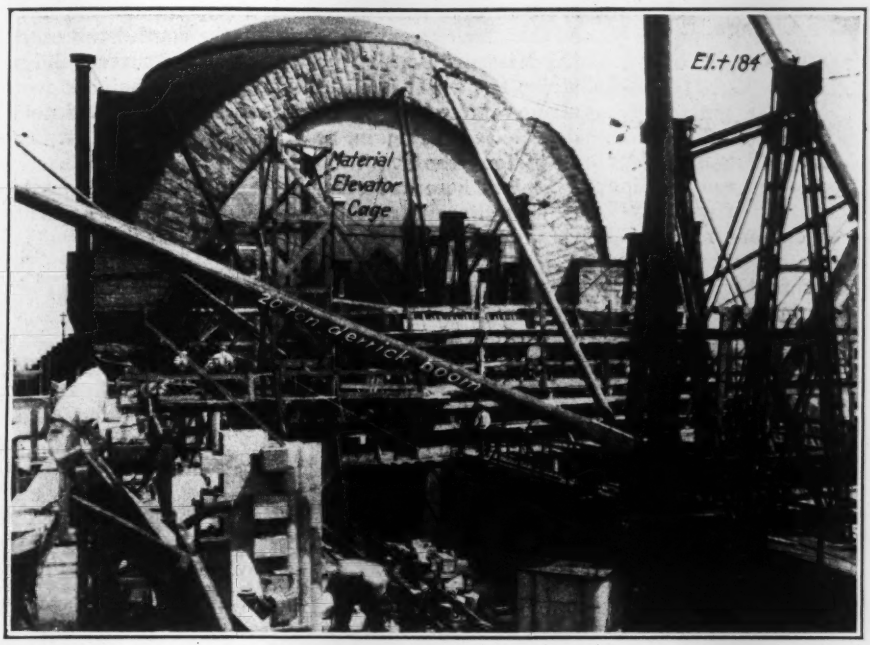


FIG. 5—THE WORKING PLATFORM 55 FT. ABOVE NAVE FLOOR
Trusses will be placed on top of the steel towers to support a platform 98 ft. above floor.

and runways for transporting material to the different parts of the structure, Fig. 6. It is at this elevation that six 20-ton derricks for all the heavy hoisting are installed. The derricks have 70-ft. booms. The hoist houses operating these derricks are placed on the nave floor, Fig. 2. Electric hoists of 50 and 75 hp. operating on direct-current are used. These derricks and a number of hand derricks reaching the various piers are being used to erect all of the lower portion of the building. They will ultimately be raised to the top platform from which position the remainder of the work will be placed. At the time that trusses *D* spanning between the large nave piers are placed, longitudinal trusses *A* and the X-bracing shown in Section *CC*, Fig. 4, will be erected. Finally the framing into this of additional trusses marked *C*, which are similar to trusses *B* on top of the towers in Fig. 2, will complete the support for the platform at El. 198.

The steel structure was not adaptable for erecting the outside walls of the ambulatory aisles to their total height of 50 ft., and here wooden scaffolding became necessary. Fire extinguishers were placed at frequent intervals along this, and it was carefully guarded at all times. The derricks on the steel structure, however, raised the stone for these walls. Fig. 3 shows the building both before and after the wooden scaffolding was removed. For supporting the necessary staging from this point upward 12-in. I-beams have been cantilevered out from the towers on each side as shown in Fig. 4.

Material yards are maintained on each side of the building (see Fig. 3), convenient to the large derricks on the towers. Small hand derricks on the ground move the stones around in the yard when necessary. A foreman in each yard is responsible for sending up the proper pieces when needed. The limestone arrives carefully wrapped in burlap. Since most of the pieces are small, a number of them may be hoisted on a skip. The same is true of the rubble backing used in the walls and buttresses. On the other hand the large pieces of granite and limestone are hoisted one at a time and deposited in place by the large hoists. Small hand derricks as a rule place the limestone and smaller granite that is over man-size. Some of the pieces of granite weigh 12 tons. In addition to the two material yards, a shop is maintained on the job where the finishing touches are put upon the carved stone. The cement mortar is mixed by hand in the crypt below the floor. It is placed in wheelbarrows and carried up to the working platform by an elevator operated by a 35-hp. electric hoist. The elevator shaft is supported against the side of one of the towers and may be seen in Fig. 5 together with the various runways leading from it to the several masonry operations.

The ordinary masonry gang consists of a stone setter who is gang boss, a fitter, and two derrick men, one helping the fitter and the other operating the bell signal rope to the hoist house on the nave floor. The hoist engineer completes the gang personnel. The gang varies

FIG. 6—SUPPORTING THE ERECTION TOWERS BUILT AROUND FOUR PAIRS OF SMALL NAVE PIERS

slightly where hand hoists are used exclusively. These gangs are distributed one on each pier and at intervals along the walls. The total labor force numbers 175 to 200 men.

Personnel—The architects for the cathedral are Cram & Ferguson of Boston. Jacob & Youngs, New York City, are the contractors for the nave with David Bell as superintendent in charge.

Missouri River Regulation at Lexington Bridge

Current Retarders Check Bank Erosion and Stabilize Channel—Possible Change in River Course Prevented

By L. J. Sverdrup

Assistant to Chief Engineer, Missouri State Highway Department

THREATENED shifting of the Missouri River channel was a serious problem in the construction of the highway bridge at Lexington, Mo., but was solved by bank protection with jetties or current retards to cause silting and the formation of a foreshore. That trouble was expected, as the river condition was very unsettled, was noted in an article by the writer on "Sinking Pier Caissons for Four Missouri River Bridges," p. 628, *Engineering News-Record* of Oct. 16, 1924.

During the summer of 1924 it was seen that the bridge could not be completed as planned unless the river changed its course decidedly. An excellent view of the situation is given by Fig. 1, which is a mosaic composed of pictures taken from an airplane flying 2,000 ft. above the river. The bank line has been crowded to the north. When the bridge was planned, considerable cutting was taking place along the south bank, while a bar was forming on the opposite side. It was thought at that time that the river would cut several hundred feet into the south bank and that the bar on the north side would build up correspondingly. But, instead, a decided cutting took place on the north bank, some distance above the bridge site. This changed the direction of the current considerably, as can be seen by Fig. 2, which shows the bank lines in 1920, in 1924 when the protection work was started and also at the present time. Over 2,000 acres of good bottom land was cut into the river before the current was brought under control.

FIG. 1—AIRPLANE VIEW SHOWS BANK EROSION — BRIDGE APPROACH AT RIGHT

As the north bank line receded, a bad situation developed, as the current coming out of the sharp bend was headed practically due south. This current was met by another current coming from the secondary chute, Fig. 2, which forced the main current in a northeasterly direction, bringing it against the revetted point where the wye track of the Missouri Pacific Ry. ends. This point, which had been heavily revetted and protected, was concave on the upstream side, so that the current was diverted in a more northerly direction. As a result, a large portion of the water went north of the north abutment of the bridge. At one time there was a channel 360 ft. wide between the abutment and the north bank, with a depth of 20 to 25 ft. adjacent to the abutment. This abutment, carried to solid rock 89 ft. below low water, is constructed like a pier, but has wing walls to conform with the slope of the fill.

After a thorough investigation the various interested parties agreed that the direction of the current must either be altered so as to restore the bank line of 1920, or the bank line must be held up to about half way between the two sloughs shown in Fig. 2, and the river then allowed to cut off the point directly below so that the current would strike the south bank east of the Missouri Pacific wye track. If the current did not strike the south bank until beyond this point it would strike an absolutely unprotected bank and would not be deflected north again, as it had been previously. Cutting along the south bank was rather desirable, as all the piers here are carried to rock. The current had to be switched from the north side before the bridge could be completed, as the structure is designed on such a grade that the north end will not afford the clearance required by the War Department.

From the navigation aspect the War Department took an active interest in the condition, as continued cutting by the river would probably produce such a sharp bend that the river could not get out to its original course and would make a cutoff which would unstabilize river conditions. It was decided that it would be difficult, if not impossible, to restore the bank line of 1920. Instead it was decided to hold the present bank line and allow the lower point to be cut off gradually. This work would take two seasons, as some of it would have to be installed one year and the river then given an opportunity to cut off part of the point in the bend before the remainder of the work was installed. The current hugged the bank nearly all the

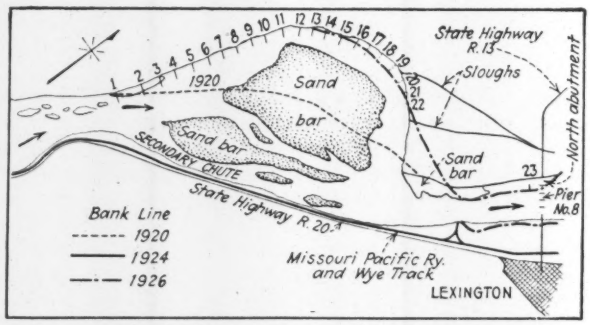
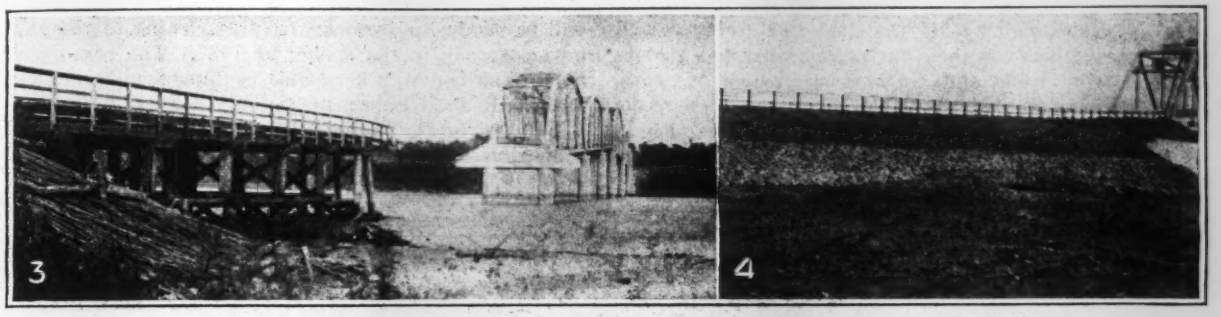


FIG. 2—MISSOURI RIVER AT LEXINGTON BRIDGE

way and no right angle attacks could be found. For the protection work it was decided to use current retards, which had been used successfully under similar conditions at Waverly and Glasgow, as described in *Engineering News-Record* of Sept. 4, 1924, p. 372.

Fig. 2 shows how the work was installed. The retards marked in solid lines were built in 1924 and those shown by dotted lines, 17 to 22, in 1925. They were built with the idea of having the current remain along the north bank line in general, only being crowded out as much as would be caused by a deposit of silt back of the retards. The 1924 work was carried approximately to the beginning of the hook, or where the bank line turns in a southeasterly direction. Here the work was stopped to give the river a chance to do some more cutting along the bank running southwest to northwest before the remainder of the work was put in. A line was staked off along this bank, forming approximately a reverse curve of the one formed by the river directly above. When the river started cutting beyond this line, the remainder of the work was gradually put in. There is a probability that the remainder of this bank line from the last retard, No. 22, will be revetted or protected in some manner for about 1,500 ft. past the retard.



FIGS. 3 AND 4—REGULATION AT NORTH APPROACH OF LEXINGTON BRIDGE

At left—North approach in March, 1925; approach trestle washed out before completion of bank protection work. At right—North approach in October of same year; protection work completed, bank silted up and approach fill built.

During the fall of 1924, the War Department decided to build a 1,500-ft. retard at retard No. 1, in order that a major part of the current would be forced away, as indicated by the arrow leading from the retard, thus relieving the bend below of a good portion of the current. About 440 ft. of this retard was built in the late fall, but in the next spring it was found that a retard 1,500 ft. long would receive the full impact of the current and could not be expected to stand up for any length of time without considerable maintenance. For this reason the idea was abandoned. A majority of the retards were 150 ft. in length; others were from 200 to 230 ft., the length depending upon the condition of the bank and the attack of the current. The ends were all about on a line. Approximately 4,750 lin.ft. of retards were built, at a contract price of $58.50 per foot.

These retards were built of trees with the trunks lashed together in groups and anchored to 15-ft. Bignell concrete piles which had an average penetration of 60 ft., with a maximum of 72 ft. and a minimum of 47½ ft., so that all anchors were buried deep enough to insure against scour. These piles have a center jet in the tip and side jets on all four sides. As the water is turned on, the pile is lifted and dropped with a churning motion. The average pressure used was 125 lb. and a pile would usually be lowered and jetted in place in 10 to 15 minutes. Thousands of trees to build up the retards were brought to the river bank with tractors and teams. They were then arranged on barges and cabled together; the barges were towed by steamboats to the retard under construction, where the groups of trees were removed and placed by hoists.

Along the north bank at the bridge, after the work was completed, the current cut off the hook and as a result the main attack shifted downstream from the Missouri Pacific wye track. As had been anticipated, a heavy cutting started immediately on the south side instead of being deflected over to the north bank. As the cutting continued on the south side, a bar started to show up on the north side, directly above the north abutment of the bridge. A 300-ft. retard had been built about 800 ft. upstream from the abutment and a bar was building up downstream from this retard. The bars finally met, and late in August, 1925, it was possible to start making the fill to complete the project. This fill, of about 28,000 cu.yd., was pumped in place in thirty days. After some mattress work and concrete block protection were completed, the bridge was formally accepted and dedicated on Nov. 4, 1925.

The north bank line is now in very good condition, and it is expected that the silting or filling along this bank near the bridge will continue for some time. It is rather hard to give even an approximate statement of the speed of silting or filling behind the retards. During high water and when this stage of water recedes, very heavy silting takes place. Some idea of the rapidity of the process may be gained from an instance where a fill about 200 ft. long, averaging 22 ft. deep and 100 ft. wide, was caused in a week of high water.

It is doubtful whether any more serious problems than this have been worked out on the Missouri River. The success of the project must be attributed to the co-operation of the War Department through Major C. C. Gee, U. S. A., district engineer at Kansas City, and to the speedy work of the contractor, Woods Brothers Construction Co., of Lincoln, Neb. B. H. Piepmeier is chief engineer of the Missouri State Highway Department, and the work came under the direct supervision of the writer, with S. J. White as resident engineer. The early planning of the work was handled by Lee Metcalf for the contractor; Wayne Pringle was chief engineer for the company and Mr. Thompson was its superintendent. Mention should be made also of the late J. R. Chamberlin, of the Omaha office of the U. S. Bureau of Public Roads, who assisted materially in the study and solution of the problem. The total cost of the work was $278,904, of which $153,162 was borne by the Missouri State Highway Commission and $125,742 by the U. S. War Department.

Ore-Dock Reconstruction in Steel and Concrete

Second Article—Great Northern Ry. Dock Combines Mass Concrete, Precast Slabs and Steel Framing—Pile Foundations

IN REBUILDING its ore dock No. 1 on Allouez Bay at Superior, Wis., for a storage capacity of 130,900 tons, the Great Northern Ry, is using a combination of structural steel framing and reinforced-concrete. Concrete columns on a concrete pier support transverse steel A-frames which carry the steel deck stringers and have framed between them the steel beams and girders for the front walls and bin bottoms, which are composed of precast concrete slabs. The transverse walls separating the bins are of cast-in-place concrete. Fig. 1 is a view of Dock 2 during its reconstruction on the same plans in 1923. Fig. 2 shows the general design adopted for both of these docks.

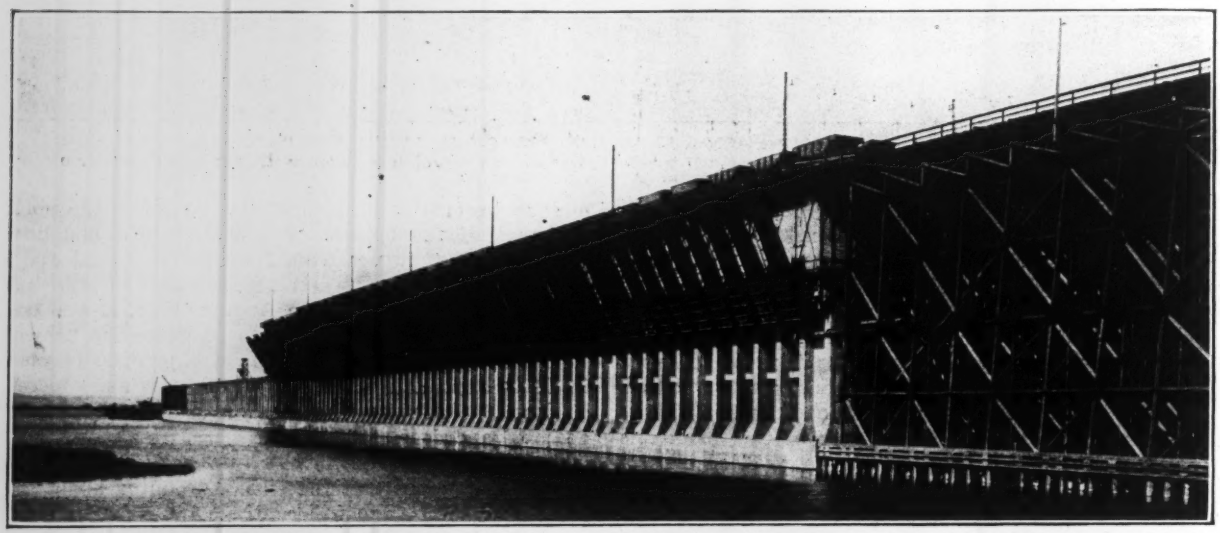


FIG. 1—ORE DOCK AT SUPERIOR, WIS.; GREAT NORTHERN RY.
Massive concrete columns support steel framing for ore pockets and deck.

Two entirely different types of construction are being used for ore docks at Superior, as noted in *Engineering News-Record*, September 16, 1926, p. 455. The Northern Pacific Ry. structure, described in that article, is entirely of concrete, with a pile and sand-filled crib foundation. The Great Northern Ry. prefers the steel and concrete design noted above, with pile foundation and no sand fill. As compared with a similar structure built entirely of concrete, this combination design is considered to give greater facility of erection, lower first cost and a reduction of about 10 per cent of weight above the foundation piling. Both the steel and the precast slabs are fabricated in advance, so that erection can be carried on conveniently during the winter, when navigation is closed, while it is possible to protect the relatively small amount of cast-in-place concrete which may have to be placed during cold weather.

This Dock 1 was built originally in 1906-07 as a timber structure, 2,244 ft. long, with 374 pockets or bins of 300 tons capacity, giving a total ore storage capacity of 112,200 gross tons. The new dock when entirely rebuilt will have a storage capacity of 130,900 gross tons, the pocket capacity being increased to 350 tons. For the new dock, the height is 80 ft. 8 in. from water level to base of rail, and 42 ft. 4 in. to the low point of the bins or tops of concrete columns. For the superstructure, the width is 56 ft. over the bin walls and 74 ft. between hand rails. During 1925 and the spring of 1926, the inner third of the length of the dock, 744 ft., with 124 pockets, was rebuilt in steel and concrete. During this period the outer two-thirds of the old dock was kept in service by constructing a temporary timber trestle across the gap. The second third is now being rebuilt according to the same design and will be ready for service with the opening of the navigation season in the spring of 1927. The new design here described was used also in the reconstruction of Dock 2, in 1923, shown in Fig. 1.

Substructure—Timber piles 55 to 90 ft. long and with a spacing of 18 to 39 in. are driven into the sand and red clay formation, the piling being braced against lateral stresses by transverse batter piles driven at an angle of about 30 deg. In Dock 2, the piles were cut off at 3 in. above the water level, while in the first and second sections of Dock 1 they were cut off at 1 in. and 5 in. below water level, respectively. No sand fill was pumped around the piles, but after they had been cut off, plank joists were spiked against their heads to carry a plank floor 3 in. below their tops. Upon this floor was built the reinforced-concrete slab or mat, 27 to 33 in. thick, but built up to 7 ft. 4 in. along each side to form pier walls, as shown in Figs. 2 and 3. Two rows of old 60-lb. track rails are embedded in the convex face of each wall to serve as fenders and distribute the pressure or impact of steamers coming alongside.

This slab is poured in lengths of 120 ft., separated by 1½-in. expansion joints which are filled with tarred box-board. It is not continuous over the entire width of the pier, but is in two longitudinal sections with an 8 ft. opening between, in order to reduce the amount of concrete. However, the two sections are tied together at intervals by concrete beams, upon which is laid a plank gangway. On each pier wall are mooring

or snubbing posts 36 ft. apart. A 60-lb. rail anchored along the edge of the wall serves to prevent men from slipping over while handling the mooring ropes. The space between the pier walls and above the slab is left

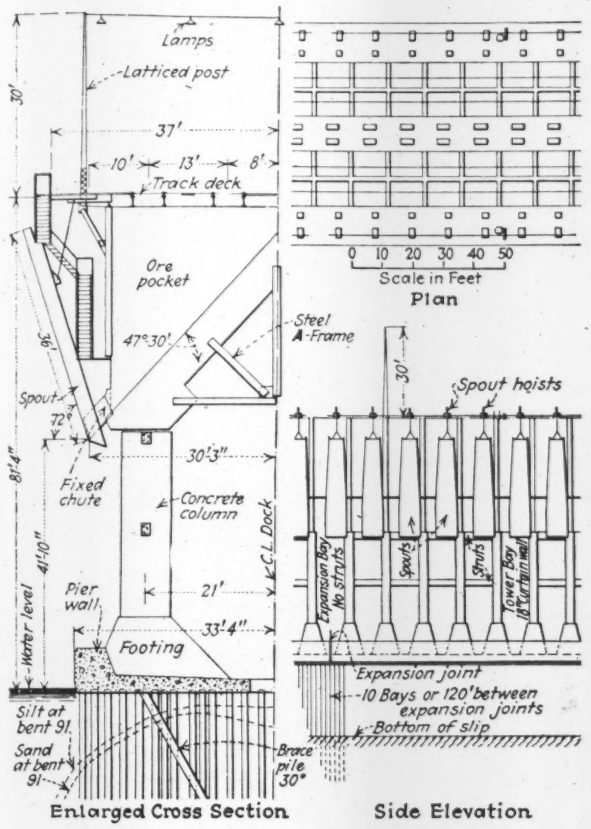


FIG. 2—GENERAL DESIGN OF ORE DOCK

empty, while in the Northern Pacific dock noted above this space is filled with sand.

Superstructure—Upon the foundation slab are pedestals carrying two rows of reinforced-concrete columns 96x33 in. in section, spaced 42 ft. c. to c. transversely and 12 ft. longitudinally. These are connected by longitudinal lines of reinforced-concrete struts, except that at the expansion joints the struts are omitted, while in the middle bay between expansion joints they are replaced by 18-in. concrete walls connecting the columns.

Across each pair of the massive concrete columns is placed a transverse steel A-frame, carrying at each end a steel post for the front wall and also supporting the vertical skeleton frame for the transverse concrete wall separating the bins. Between the posts are horizontal struts, while between the A-frames are I-beams and girders to support the bottoms of the bins. On top is the deck framing, consisting of 18-in. I-beams as track stringers, together with lighter beams along the edge of the deck, all connected by transverse members of angles and channels. Expansion joints are provided at intervals of 120 ft., or ten bays, while the two bents at the middle of each 120-ft. length are connected by diagonal reinforcement in the curtain wall so as to form a braced or tower bay.

Precast concrete slabs or panels 8 in. thick and 68x115 in. in size, weighing about 5,500 lb. each, are laid upon the steel framing of the bin bottoms, and have the joints grouted with cement. The slab concrete is a 1:2:4 mix, made with crushed stone and having a smooth dense surface to resist abrasion. Similar slabs, 9 in. thick and 54x132 in. in size, weighing about 5,600 lb., are fitted to the vertical framing to form the front walls of the bins. All exposed steel is protected with graphite or carbon paint.

For the transverse concrete walls, which are 12 in. thick, form panels are placed against the vertical steel ribs and concrete is cast in place, filling also the vertical steel posts in the front walls. The deck framing is open over the bins, except for a plank gangway between each pair of tracks. Between the inner tracks and outside of the outer tracks there is a plank flooring. Rails of 90-lb. per yard for the four tracks are laid directly upon the 18-in. I-beam stringers, to which they are secured by clips 3 ft. apart. These clips, 3½ in. long, are shaped like angle splice bars, but with the flanges bent round so as to hook over the edges of the I-beams. Each pair of clips is secured by a bolt through the rail.

Gates and Spouts—In the front wall of each pocket is a discharge opening 4 ft. high and 7 ft. wide, placed at one side of the center line, so that the bottom of the pocket has beveled corners with surfaces sloping in both

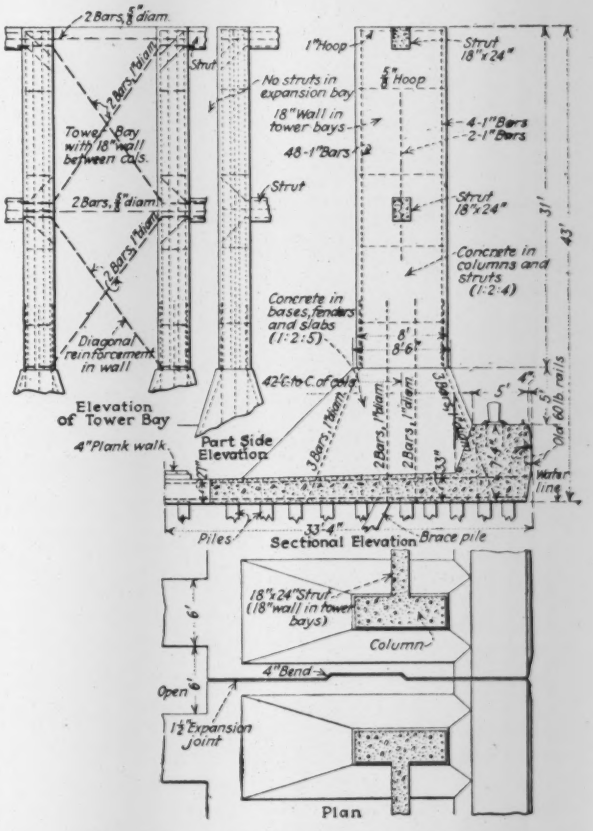


FIG. 3—CONCRETE PIER AND COLUMNS

directions to this opening. This arrangement is considered to give a freer flow, with less chance of clogging, than if the opening was in the middle of the bin, since it breaks up the arching action of the ore. The opening is fitted with a fixed chute and a sliding gate which is operated mechanically from a spool on the

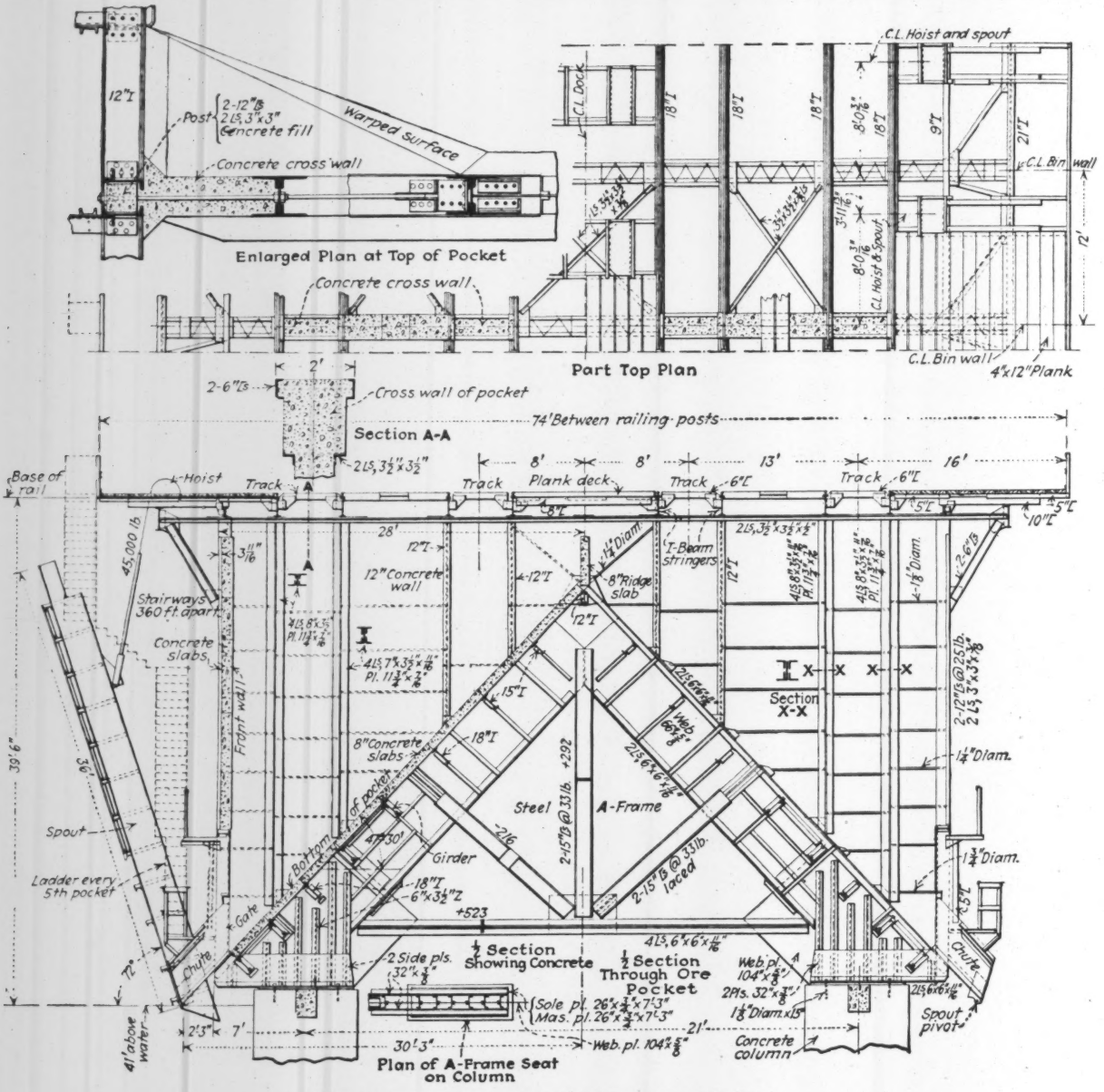


FIG. 4—STEEL AND CONCRETE ORE BIN DESIGN
Structure steel framing. Precast concrete slabs for bottom and front walls of bins or pockets. Poured concrete for cross walls

hoist machine in connection with the 36-ft. hinged spout.

On other ore docks it has been found that in lowering such spouts they become bent on account of straps or angle irons breaking at the point where they strike the coaming of the ship's deck hatchways, causing a ridge in the bottom spout plates which wears rapidly by the sliding stream of ore. To eliminate this trouble, the new spouts have wooden bumping blocks bolted to the underside and armored with steel straps to take the impact at the hatchways.

Line shafting along each side of the deck in lengths of 120 ft., each driven by a 25-hp. electric motor, provides for operating the spout and gate hoists. Each hoist is thrown into gear by means of a clutch, but is stopped automatically when the gate or spout is at the end of its travel. Steel latticed posts 300 ft. apart along the edges of the deck carry transverse wires 30 ft. above the rails, from which are hung five electric lamps of 150 to 200 watts each. Pipes for compressed air are laid along the deck to serve pnuematic hammers used in loosening frozen or clogged ore in the cars.

Design and Construction—This new type of ore dock was designed and built under the direction of J. R. W. Davis, chief engineer, Great Northern Ry.; J. A. Bohland, bridge engineer, and N. J. Seyton, district engineer. For both sections of the reconstruction as described above, the substructure was built by the Barnett & Record Co., Minneapolis, Minn.; the steel framing was fabricated by the the American Bridge Co., and the precast concrete slabs were made by Grant, Smith & Co. and Walter Bennett, both of St. Paul. For the steel and slab erection and cast-in-place concrete work on the first section, the contract was let to the

Sanitor Construction Co., now the Industrial Contracting Co., Minneapolis, Minn. For erection on the second section, which will be done next winter, the contract has not been let. Wrecking of the first section of the old timber dock was done by the Barnett & Record Co., while that of the outer two-thirds was done by the Peppard & Fulton Co., Superior, Wis.

Four parallel ore docks separated by slips 200 ft. wide, with a minimum depth of about 23 ft. of water form the Great Northern Ry. ore shipping plant on Allouez Bay. Three of these are of steel and concrete, including dock No. 1 now being rebuilt, while the other is of timber with concrete bin bottoms and modern operating machinery and equipment. In docks 1 and 2 the deck and framing are designed for Cooper's E-60 loading, with 50 per cent of the A.R.E.A. allowance for impact added for track stringers and deck posts. The weight of ore is about 160 lb. per cubic foot, and as its angle of repose is about 45 deg. the bottoms of the bins are sloped 47½ deg. in order to give free flow and discharge.

From the receiving yard adjacent to the docks, yard engines take trains of 30 to 40 hopper-bottom cars, which are of 50 and 75 tons load capacity, having an average ore-car load of about 60 gross tons. A crew on the floor of the ore dock releases and latches the hopper doors, a train load being dumped and ready for the return trip in about 30 minutes after being stopped over the pockets. When a large ore boat of about 9,000 tons cargo capacity has been moored in position it can be loaded in an average time of 3¼ hours.

Annual Costs of Highway Bridges in Oregon

A GROUP of interesting curve plots is reproduced herewith from a paper presented by C. B. McCullough, bridge engineer of the Oregon highway department, before the structural division of the American Society of Civil Engineers at its recent Seattle meeting. The data in the first six diagrams represent maintenance cost only, expressed in per cent of total cost; these data are from actual costs during ten years and advance estimates of expenses for five to ten years more. The curves in the last diagram, Fig. 7, represent the sum of annual maintenance and annual renewal charge for different lengths of bridge life, based on an extrapolation to 40 years (Fig. 6) of the maintenance data of Figs. 1 to 5.

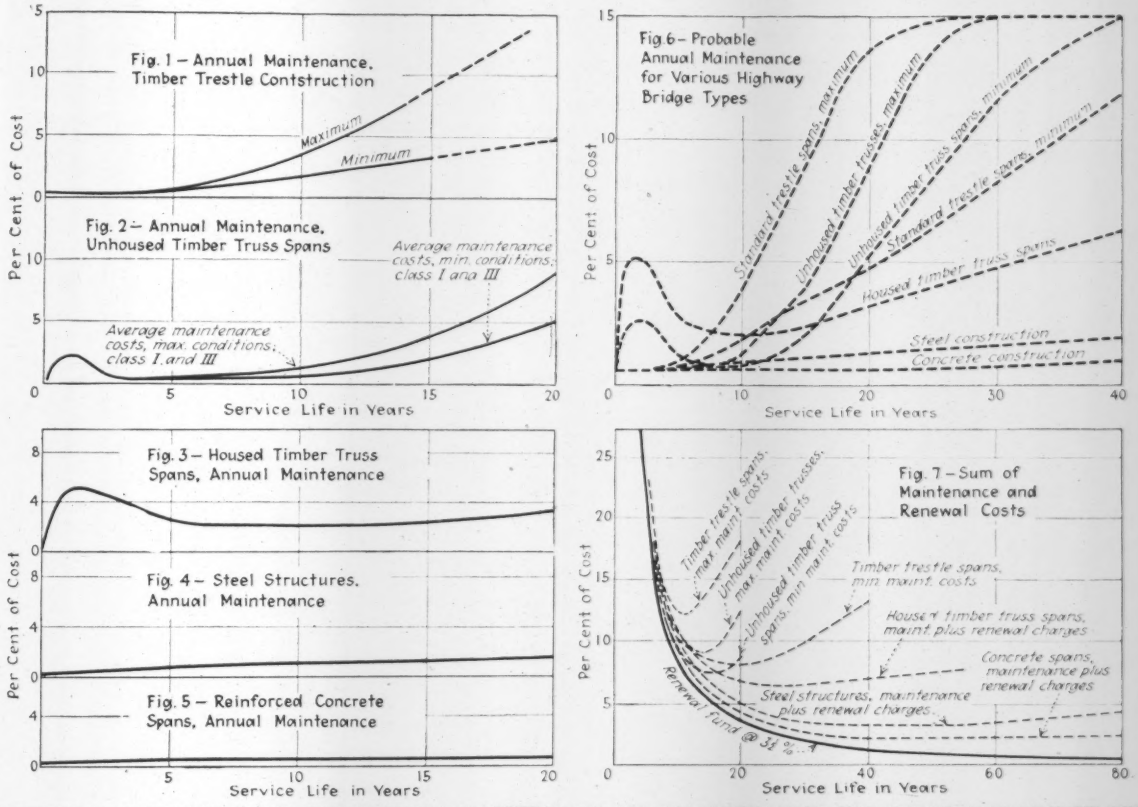


Fig. 1 – Annual Maintenance, Timber Trestle Contstruction
Maximum
Minimum
Fig. 2 – Annual Maintenance, Unhoused Timber Truss Spans
Average maintenance costs, min. conditions, class I and III
Average maintenance costs, max. conditions, class I and III
Per Cent. of Cost
Service Life in Years
Fig. 3 – Housed Timber Truss Spans, Annual Maintenance
Fig. 4 – Steel Structures, Annual Maintenance
Fig. 5 – Reinforced Concrete Spans, Annual Maintenance
Per Cent of Cost
Service Life in Years
Fig. 6 – Probable Annual Maintenance for Various Highway Bridge Types
Standard trestle spans, maximum
Unhoused timber trusses, maximum
Unhoused timber truss spans, minimum
Standard trestle spans, minimum
Housed timber truss spans
Steel construction
Concrete construction
Per Cent of Cost
Service Life in Years
Fig. 7 – Sum of Maintenance and Renewal Costs
Timber trestle spans, min maint. costs
Housed timber truss spans, maint plus renewal charges
Concrete spans, maintenance plus renewal charges
Steel structures, maintenance plus renewal charges
Renewal fund @ 3½ %
Per Cent of Cost
Service Life in Years

CURVES OF MAINTENANCE AND TOTAL COST (AMORTIZATION AND MAINTENANCE) FOR DIFFERENT BRIDGE TYPES
Based on 10-year data from Oregon highway bridge experience reported by C. B. McCullough, bridge engineer, Oregon Highway Department.

The maintenance-plus-renewal curves all show a minimum at some point, where the decreased renewal charge for the greater length of life is outbalanced by the increase in annual maintenance. The minimum of

SERVICE LIFE, AND MAINTENANCE AND RENEWAL COST

	Range of Economic Service Life	Unit Renewal and Maintenance Cost
Timber Structures	Years	Per cent
Most favorable conditions	18-20	8.0
Unhoused trusses, most unfavorable conditions	12-15	9.0
Most favorable conditions	15-17	7.3
Housed truss spans	25-35	6.2
Steel spans	25-65	3.2
Concrete construction	40-80	2.1

the curves is considered to be the economic length of life of the type of bridge represented. The annual renewal charge has been calculated on a basis of 3½ per cent interest, though Mr. McCullough says that the curves would not be greatly modified if 4 or 4½ per cent were used. The accompanying tabulation represents conclusions from Figs. 7 and 8.

The values in the last column are raised about 3 to 5 per cent by adding interest and insurance, less a small credit for general community benefit other than traffic service.

Motor Vehicle Registration Based on Average Income

Evidence Indicates Relation Between Motor Vehicle Registration and Income of People—Rule Applied in Tennessee

By N. W. Dougherty

Professor of Civil Engineering, University of Tennessee, Knoxville and Special Assistant, Tennessee State Highway Department, Nashville, Tenn.

MOTOR VEHICLE registration in any community is affected by a number of factors, many of which are difficult to measure. However, taking the United States as a whole, there seems to be a relation between motor vehicle ownership and the income of the people. Two maps, Figs. 1 and 2, have been prepared showing density of motor vehicle registration and average income per capita for 1919, 1921 and 1922. Notice that eleven of the southern states are grouped together for motor vehicle registration, and that these same states have the lowest average income per capita for

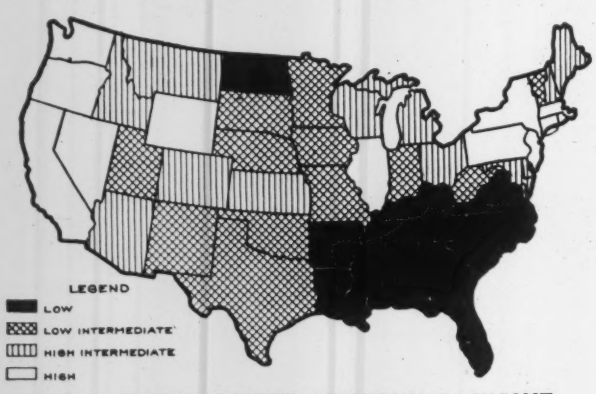


FIG. 1—STATES GROUPED ACCORDING TO INCOME PER CAPITA

the years named. It would therefore seem that the lag in motor vehicle registration in the southern states is somewhat due to the average income in this section. In the intermediate groups of states the same rule seems to apply, though in high income states the motor vehicle registration is lower than in other states in the Union. This, no doubt, is largely due to another factor which affects motor vehicle registration; namely, other transportation facilities.

In the congested areas throughout the middle Atlantic states, the density of motor vehicle registration is less than in the agricultural section of the middle west. An explanation seems to be in the density of population and relative transportation facilities in the two areas. The middle Atlantic states have many more people per square mile of area than the agricultural states. There transportation facilities, other than motor vehicles, furnish more convenient transportation than the other methods in agricultural states, causing them to require fewer motor vehicles to take care of their transportation needs.

The graph, Fig. 3, showing income per year and increase in motor vehicle registration indicates the

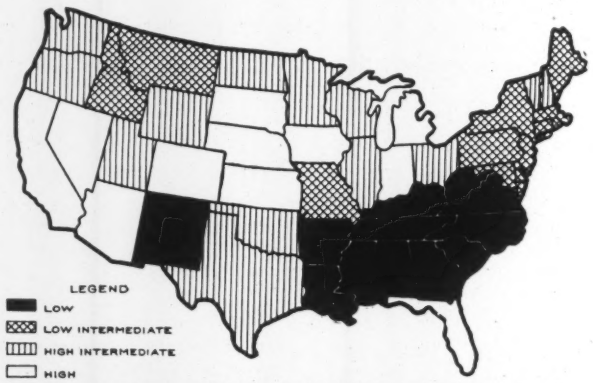


FIG. 2—STATES GROUPED ACCORDING TO DENSITY OF MOTOR VEHICLE REGISTRATION

same relation between income and registration as is shown by the two maps. The income used is only that indicated by income tax returns, while the income on the two maps is from total income. Note the break in all four curves for 1921 and the increases for 1922 and 1923.

The third factor which no doubt has its effect on the purchase and use of motor vehicles is the condition of the public thoroughfares, though the effect of this factor is somewhat difficult to measure. In certain counties of Tennessee before highways were improved, the motor vehicle registration was low. Immediately after the improvement, there was a jump in registration above the average increase for the state, indicating that registration is dependent upon the ability of the owner to use his vehicle for pleasure and profit.

Method of Predicting Future Registration—Tennessee is an average southern state. When income per capita, taxable wealth per capita, motor vehicle registration per mile of road and other such factors are considered, Tennessee ranks about with the average of the eleven southern states, excluding Florida. The latter state has an unusually large motor vehicle registration, largely due to the great influx of transients into the state.

To arrive at what Tennessee's motor vehicle registration should be for the next few years, two curves, Fig. 4, have been plotted. The first curve is made up as a composite curve from the vehicle registration in four states which have a denser registration than Tennessee. The four states chosen are Kansas, Missouri, Indiana, and Iowa. Kansas, Iowa and Indiana are largely agricultural states, while Missouri and Indiana have a large amount of manufacturing and industry. Tennessee has as its major occupation agriculture, though manufacturing and other forms of industry are rapidly developing. The composite curve was made by superimposing the curve of these four states upon each other at points nearest ten persons per motor vehicle. The

average of the four points then was taken for the average curve. Tennessee's curve was obtained by computing the density of motor vehicle registration, going back to 1917 and extending the curve to 1925.

The figure shows that the two curves are similar, though the increase in registration for the composite curve is somewhat more rapid than that for the Tennessee curve. The composite curve projects forward on the diagram to 1930, giving a motor vehicle intensity of one vehicle to 3.8 persons. A plotted hyperbola placed on these two curves conforms very closeley to the plotted points. It is therefore assumed that both curves may be projected forward in the general form of the hyperbola. Projecting Tennessee's curve forward, a registration density for 1935 of one vehicle to 6, or 5, persons seems reasonable, giving the following tabulation:

Year	Registration — Probable	Registration — Minimum
1926	275,000	272,000
1927	307,000	300,000
1928	344,000	328,000
1929	372,000	346,000
1930	398,000	358,000
1931	430,000	378,000
1932	455,000	386,000
1933	475,000	400,000
1934	495,000	415,000
1935	519,000	430,000

Little credence should be put in these figures after the year 1930, since a change in economic conditions in Tennessee or other factors affecting registration may radically change the trend of the curve. To show how closely this method of projecting the registration checks with the facts, the following figures are cited:

In the summer of 1924 when the data for 1923 were available, an estimate was made for 1924 and 1925.

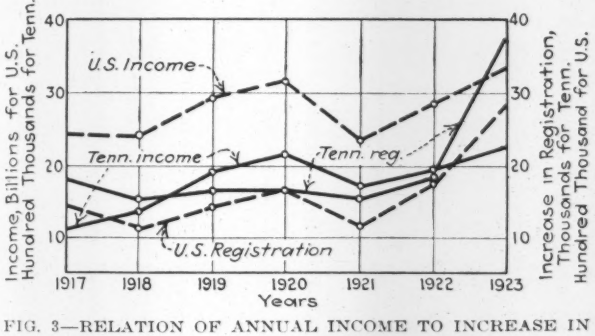


FIG. 3—RELATION OF ANNUAL INCOME TO INCREASE IN MOTOR VEHICLE REGISTRATION

The prediction for 1924 was 203,000 and 1925, 237,000. Actual registration for these years was 206,737 and 245,819. The prediction for 1926 is 275,000. The actual registration to July 1, 1926, was 249,570. Last year's record shows an increase from July 1 to Dec. 31 of approximately 20,000.

Use of Data—The finance program of the highway department is bound up in the motor vehicle registration, since Tennessee's state income for highways is wholly from license fees and the gasoline tax. The 1925 legislature raised the gasoline tax from two to three cents per gallon, and left the license fees at an average of approximately $12 per motor vehicle. The highway department has completed estimates of the cost of construction on the primary highways and on the other highways which will need improvements during the next five years. The estimates show what the department needs will be during this period. The estimates of motor vehicle income give indications of what future legislation should be to furnish the funds needed.

If the motor vehicle registration were known accurately, it would still be a problem to estimate exactly

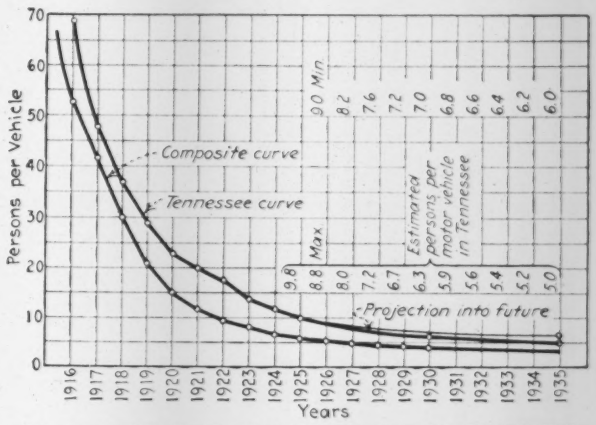


FIG. 4—PERSONS PER MOTOR VEHICLE BY YEARS FOR TENNESSEE

the income from the gasoline tax. The estimated income for 1925 made in 1924 by the method outlined above, was $6,050,000. The actual income was $5,817,238. The difference, no doubt, was due to the decreased consumption of gasoline per motor vehicle per year. What the consumption will be by 1930 is still more difficult to tell.

Future Traffic—On many of the highways in Tennessee, the department is in the initial stages of construction. Estimates of traffic therefore are necessary for an intelligent selection of the improvements and maintenance program. It has been found in Tennessee, and data from other states confirm the conclusion, that traffic increases approximately as motor vehicle registration. By 1930 motor vehicle registration in Tennessee will be 1.87 times the registration in 1925, meaning that traffic on the whole will be increased about one hundred per cent. On individual highways the traffic will not increase in the same ratio as may be expected for the average, but a careful analysis of local conditions will assist the engineer in predicting what the traffic on the local highways will be.

Trend by Division—Applying the method to smaller areas than the state, the registration trend for the four divisions of Tennessee will be noted:

Division	Persons per Vehicle — 1920	Persons per Vehicle — 1925
1	28.8	10.7
2	26.2	11.1
3	20.4	9.0
4	18.5	9.1
State	22.9	9.85

It will be noted that the present density of registration in the first two divisions is less than the density for the other two divisions, but the rate of increase for the first two seems to be greater than for the third and fourth. The indication is that the traffic in the first and second divisions will increase more rapidly while traffic in the third and fourth divisions will probably increase less rapidly than the average for the state. A possible exception is the second division, where other factors such as income per capita will affect the motor vehicle registration.

Erecting a Self-Anchored Suspension Bridge—Seventh Street Bridge at Pittsburgh

Bold Method of Construction Adopted in Order to Avoid Falsework in Channel—Each Half Built as a Cantilever, with Temporary Diagonal Struts Between Chains and Stiffening Girder

By V. R. Covell
Chief Engineer of Bridges, Department of Public Works of Allegheny County, Pittsburgh, Pa.

CANTILEVER erection was used in the construction of the self-anchored suspension bridge over the Allegheny River at Seventh St., Pittsburgh, completed some months ago. The highly original and bold structure was described in *Engineering News-Record* of Dec. 18, 1924, p. 995. Its unusual structural character created a remarkably difficult erection problem, which was solved most excellently by the American Bridge Co., contractor for the superstructure. The following brief outline of the method used has therefore been prepared, with the co-operation of P. J. Reich, the company's division engineer at Pittsburgh, and the following members of the county's Department of Public Works: T. J. Wilkerson, consulting engineer; A. D. Nutter, chief design engineer; H. K. Dodge, designer; and C. K. Harvey, assistant engineer in charge of field work.

A reference to the design will make the erection problem clearer. Fig. 3 shows an outline and some structural features of the bridge, reproduced from the earlier article already mentioned. It should be added that the new bridges to be built at Sixth and Ninth Sts. are of the same design, and almost of the same dimensions. The Ninth St. bridge is now being erected and should reach closure by early autumn.

Description—The bridge is a highway structure carrying four lines of traffic (two lanes for vehicles and two street-car tracks) on the roadway, and a cantilevered footwalk on each side. The roadway pavement consists of a 2½-in. layer of asphaltic concrete laid on a concrete base averaging 5 in. in thickness on ⅜-in. buckle-plates, while the sidewalk pavement consists of a 1-in. surface of rock asphalt laid on a 5-in. reinforced-concrete slab. The dimensions of the main or suspended portion of the structure are:

Width of roadway 37 ft. 6 in. between curbs.
Width of sidewalk 12 ft. 1½ in. center of girders to center of railing.
Width center to center of girders and suspension system, 42 ft. 6 in.
Length of each side span, 10 panels of 22 ft. 1¼ in; 221 ft. ½ in.
Length of center span, 20 panels of 22 ft. 1¼ in., or 442 ft. 1 in.
Height of towers, 77 ft. 11⅜ in.
Sag of suspension chain, 55 ft. 5½ in.
Grade, 4.17⅝ per cent, with a vertical curve for 8 panels at the center.

The structure may be briefly described as a self-anchored suspension bridge. The suspension system consists of 14-in. eyebars extending from anchorage to anchorage, having two pins on the top of each tower, and carrying the roadway by 4-in. eyebar suspenders at the panel points. The stiffening system consists of triple-web plate girders placed parallel to the grade. The horizontal component of the stress in the eyebar chain is taken by the stiffening girders, while the reactions at the ends are vertical. The girders are thus subjected to stresses due to bending combined with direct compression.

Erection of the Structure—Three principal methods were considered:

(1) To provide a temporary anchorage to support the suspension chain until the stiffening girders were connected up. This was discarded on account of lack of room for anchorage and unfavorable soil conditions, combined with the time element, which was an important factor.

(2) To erect the entire structure on falsework. This

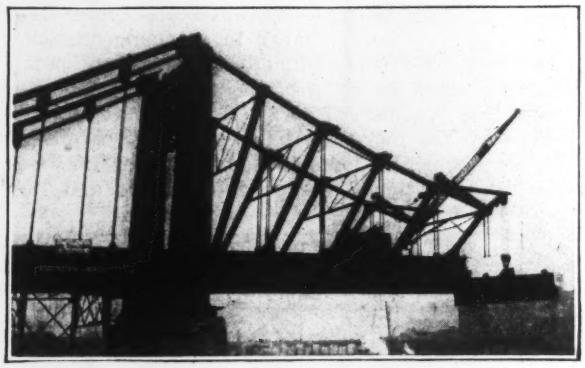


FIG. 1—SEVENTH ST. BRIDGE DURING ERECTION
View taken Nov. 17, 1925.

was not practicable because of navigation requirements; it would also have delayed erection about six months.

(3) To erect as a cantilever. This method was independent of temporary anchorages and practically independent of navigation and flood conditions.

The choice of method was left to the bidders, the only restrictions being those required for navigation and the time of completion. The American Bridge Co. was the successful bidder, and its engineers developed the third method, one never before used on this type of structure.

For convenience the sketch, Fig. 4, may be referred to. In the following description panel-points L_0 to L_{19} will denote the south or Pittsburgh half, and L'_0 to L'_{19} the north or Allegheny half of the bridge. Erection was carried on simultaneously from the north and south to the center of the bridge at L_{20}.

Wood piles carrying steel bents were driven at panel points 1 to 9 inclusive, those at panel points 4 and 7 being extra strong to provide for protection against floods in case the remainder of the falsework was carried out.

All material except that for the girder approach spans was delivered at the bridge site in steel barges, and picked up directly from them as needed for erection.

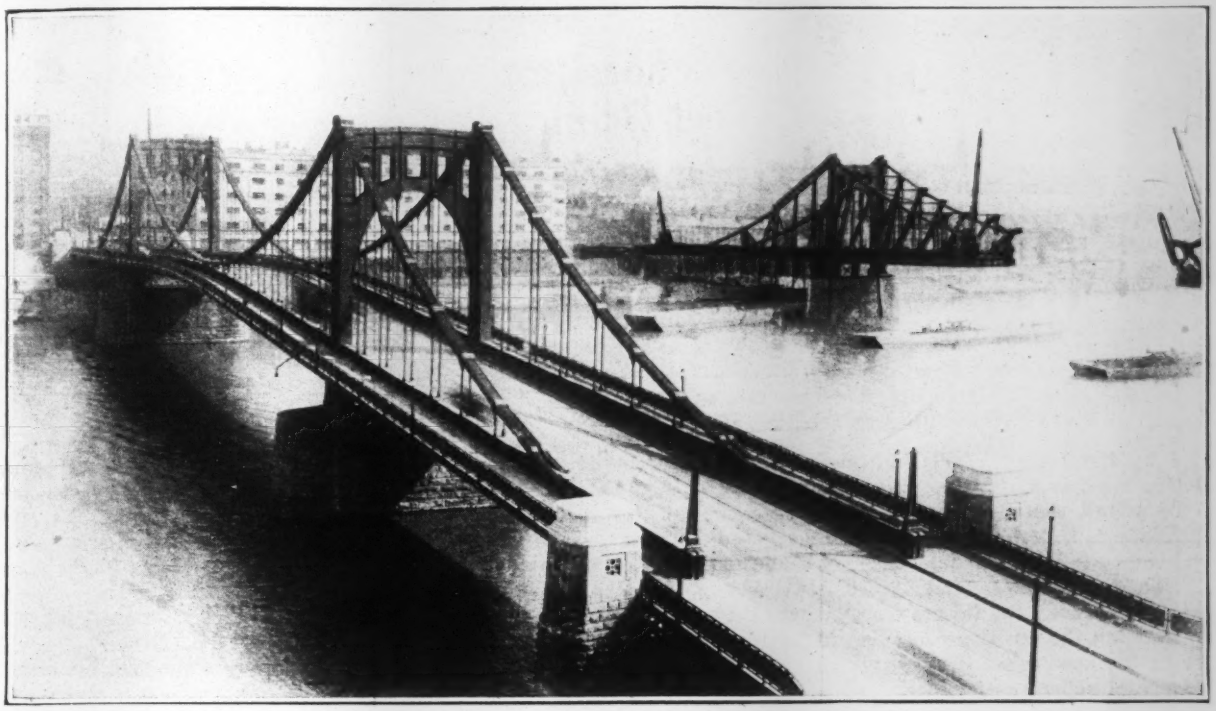


FIG. 2—SEVENTH ST. BRIDGE AT PITTSBURGH, COMPLETED
View taken July 21, 1926. The bridge was thrown open to traffic on June 17. Erection of the Ninth St. bridge is seen at the right.

The floor system was first erected from L_0 to L_{10} by locomotive crane weighing 100 tons, running on tracks on the erected floor, after which the stiffening girders and the eyebar chains were set. The girders were then jacked to their cambered position and the splices fully bolted up, the tower bases having been previously set. The towers were erected and held in position by adjustable struts joined at bottom to the stiffening girders.

The eyebars and hangers were erected in their final position from panel points 0 to 3. From panel points U_2 to U_5 and U_6 to U_7 the eyebars were cradled and had their intermediate pins at U_4 and U_6 supported by the I-beam cradles. Points U_5 and U_7 were carried on special struts. Eyebars U_7 to U_{10} were similarly carried on I-beams supported at U_7 and the top of the tower, U_{10}; the intermediate points U_8 and U_9 were car-

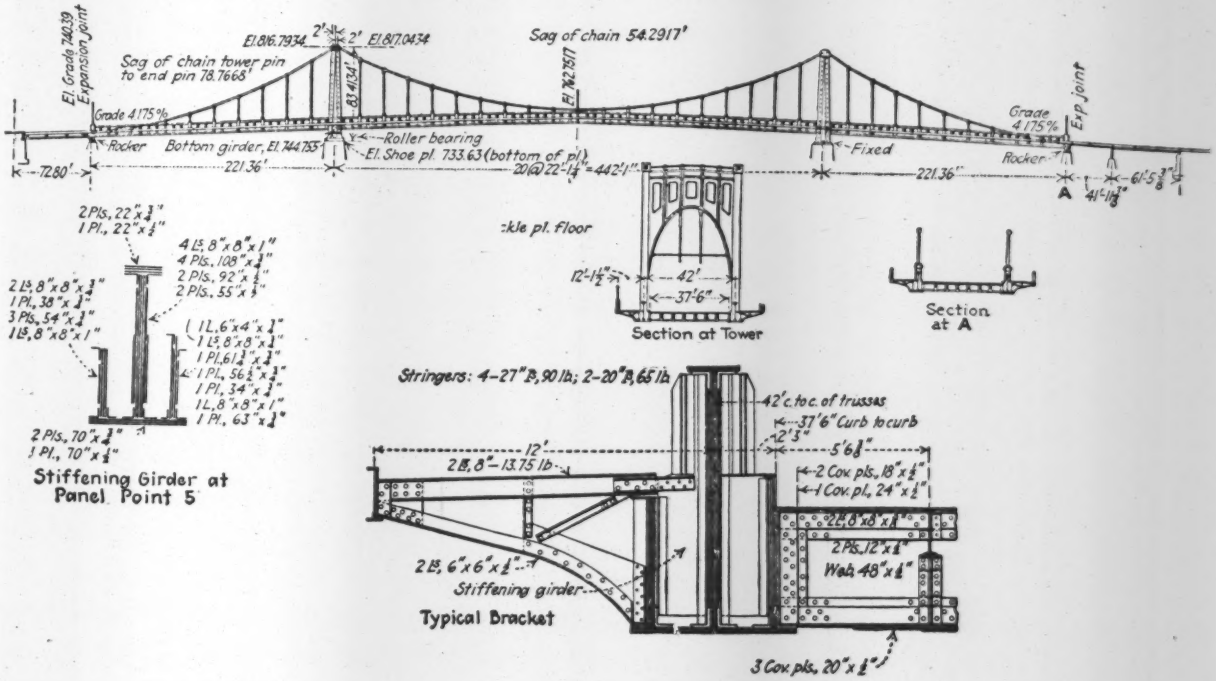


FIG. 3—GENERAL DESIGN FEATURES OF SEVENTH ST. BRIDGE, PITTSBURGH

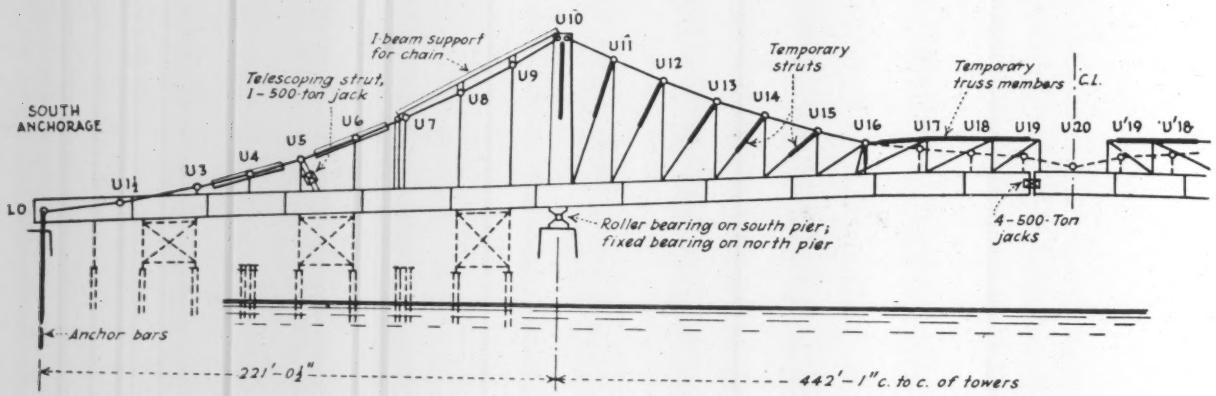


FIG. 4—ERECTION DIAGRAM, SHOWING TEMPORARY MEMBERS AND PROVISION FOR ADJUSTMENT

ried by the I-beam cradles by means of plates with slotted holes engaging the pins.

To permit the eyebar chains to be connected at U_{20} the distance between the towers was decreased one foot and the bottom hanger pins were not connected at L_4 to L_6 inclusive and at L_{17} and L'_{17}. The decreasing of the distance between the towers one foot was accomplished by starting the erection of L_0 one foot toward the center of the span from its final position and setting the segmental rollers at L_{10} in an inclined position corresponding to this movement. The segmental rollers were then locked by temporary plates to prevent any further movement. The corresponding north part of the structure was erected in its final position.

The difficulty in connecting pins at U_{20} was due to the deflection of the cantilever, which was on a 4.175 per cent grade, and the cambered length of the members.

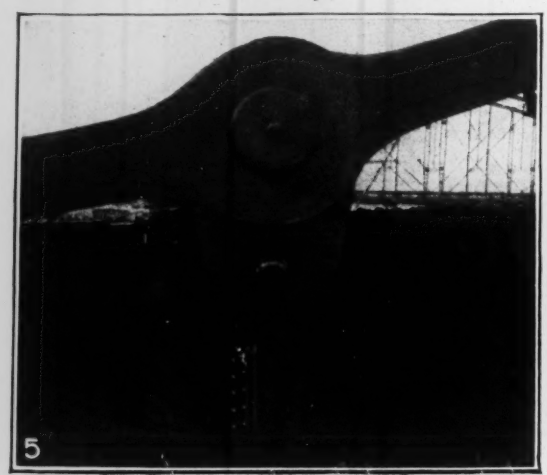
A telescopic strut, containing one 500-ton jack, so constructed that it could act either in tension or compression, supported the eyebar chain at U_5, normal to the tangent of the curve of the chain.

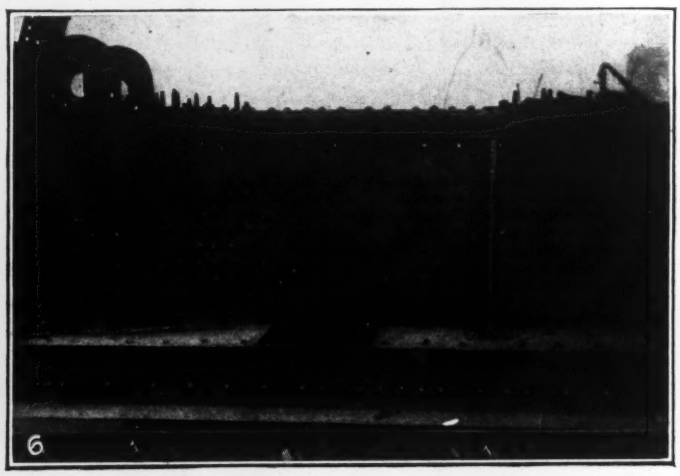
The function of this strut was to control the secondary stresses in the cantilever by pulling the tower back as deflections increased, to control the elevation of L_{19} to assist in the final closure, and to permit connecting the bottom pins at panel points L_4 and L_6 inclusive.

Cantilever Erection—The remaining portion of the structure was erected as an ordinary cantilever arm, temporary diagonal erection struts being placed in panels 10-11 to 15-16 inclusive. The struts had pin plates at their upper ends, engaging the pins outside the bars, and temporary bolted connections to the girders at the lower ends. The erection stresses were of the same kind as the permanent stresses, but it was necessary to increase the section of the hangers U_{11}-L_{11}.

Beyond point U_{17} the inclination of the erection diagonals would have been too flat, so that it was necessary to construct a truss having its top chord and web system entirely independent of any permanent material, the stiffening girders still acting as the lower chord. This truss was a second cantilevered arm attached to the first by means of a tie from U_{17} to the pin at U_{16}, having an effective depth of 16½ ft., with the verticals placed ahead of the permanent panel points. This allowed the completion of the erection up to the splices located 3 ft. 8 in. beyond panel points 19 and 19′.

The nominal distance between these splices is 44 ft. 2½ in. less 7 ft. 4 in., or 36 ft. 10½ in., and as panel point 19 was one foot north of its final position the opening would be approximately 35 ft. 10½ in. in length. The girder section L_{19} L'_{19} was fabricated 35 ft. 8½ in. in length, or 14 in. short, thus leaving 2 in. for clearance. This section was supported from the cantilever truss while the eyebar chains were connected. Four 500-ton jacks were placed in each chord in such a manner that their combined force would pass through the





FIGS. 5 AND 6—TWO DETAILS—HANGER PLATE AND SPLICE OF STIFFENING GIRDER

FIG. 7—CANTILEVER END NEARING CLOSURE
Temporary truss framing was used near the middle to give increased depth until closure.

center of gravity of the cross-section of the stiffening girders. These jacks acted on suitable diaphragms, built into the chords near L_{10}.

With the center heavy girder section in place, together with the jacks, the locking plates on the roller shoes at L_{10} were taken off. The pins at U_{20} were then driven, completing the eyebar chain with practically no stress. The hanger pins from L_{17} to L'_{17} were then driven and, immediately following, the pins at L_4, L_5 and L_6 and the corresponding pins on the opposite half were driven. Connecting these pins placed some stress on the bottom-chord jacks. Jacking was then started, converting the spans from cantilever to suspension type. The cantilever spans had the regular cantilever droop, so that, as jacking proceeded, the center of the channel span rose vertically and at the same time the south half of the structure was moved to its final position.

As the jacking stress approached the compression stress in the heavy chords (dead weight of steel plus erection equipment), the diagonals of the cantilever truss freed themselves, leaving the bridge a suspension span. At this point, the closing 14-in. section of the girder was entered, thus completing the stiffening girders. This 14-in. section was then restrained by adequate cover splices, all points riveted up and the jacks removed.

It was observed that when the span had reached its final position the stress as indicated by pressure gages on the jacks agreed very closely with the computed stress in the girders for the load then on the structure.

The erection of the steelwork of this bridge was commenced July 7, 1925; closure of the stiffening girders was made Feb. 9, 1926; and the bridge was thrown open to traffic June 17, this year.

Twelve-Mile Chilean Railway Has 62 Curves

A Chilean railway 18,700 meters or about twelve miles long, begun in 1924, from Pedegua to Petoroa in the Province of Aconcagua, has been completed and accepted. The new line cost approximately 3,000,000 pesos, is of meter gage, and in its twelve miles of length contains 62 curves.

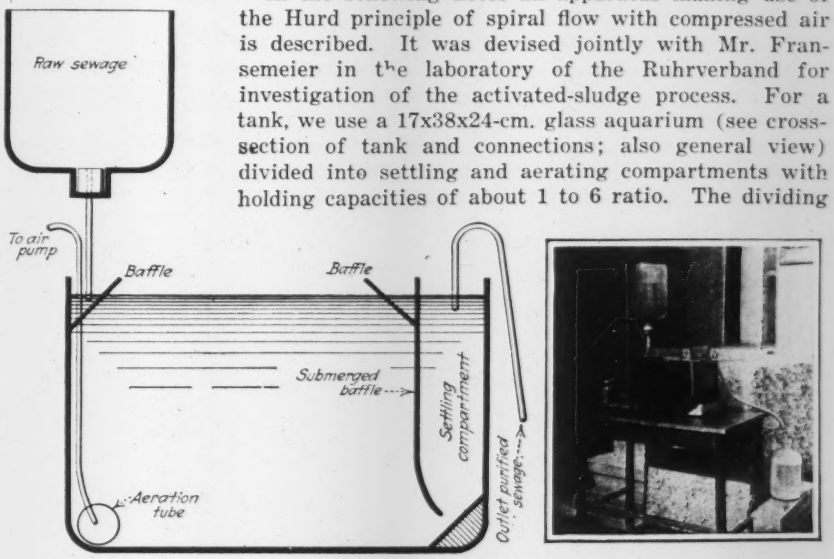
Apparatus for Activated-Sludge Tests at Essen, Germany

By Dr. F. Sierp
Ruhrverband, Essen, Germany

Translated by Abel Wolman, engineer, Maryland Board of Health, Baltimore, with the co-operation of Dr. Karl Imhoff, engineer, Ruhrverband.

THE Ruhrverband is operating at its Essen-Rellinghausen sewage-works, a laboratory-scale experimental activated-sludge tank. Elsewhere in Germany, experiments with activated sludge are being made. Most of the testing tanks have a minimum of 0.5 cu.m. holding capacity. Even though such tests may not give the best basis for the construction of larger plants, there are many instances in which one may study the experiments on a small laboratory scale with profit. For such laboratory investigations, we have previously used either tall cylinders (about 1 m. high and from 10 to 15 cm. in diameter) or flasks, fitted with round filtros aerating plates.

In the following notes an apparatus making use of the Hurd principle of spiral flow with compressed air is described. It was devised jointly with Mr. Fransemeier in the laboratory of the Ruhrverband for investigation of the activated-sludge process. For a tank, we use a 17x38x24-cm. glass aquarium (see cross-section of tank and connections; also general view) divided into settling and aerating compartments with holding capacities of about 1 to 6 ratio. The dividing



APPARATUS FOR ACTIVATED-SLUDGE TESTS

wall has its ends inserted in rubber tubing cut lengthwise in order to provide a tight joint between the glass wall and the metal. At either end of the aerating tank there are two inclined baffle plates at the top arranged and fastened in similar fashion, so as to provide for the typical spiral flow of air and sewage. For air diffusion a chamois tube with an internal diameter of 2 cm. is used, which is connected by glass tubing with the source of air. In the upper part of the settling chamber there is a lead overflow pipe for the effluent.

The sewage flows continuously into the aeration chamber at the same rate as the effluent is removed, the rate being regulated by a pinch cock on the outlet of the supply flask. To obtain activated sludge, we aerate strong sewage 24 hours, allow the sludge to settle, remove the supernatant water and fill again with sewage. This is repeated for several days until we have from two to three volumes of sludge, when the operation may be started with the sewage that is to be tested.

We have used the apparatus for many tests with activated sludge. It has produced excellent results.

Piers Sunk by Varying Air Methods for New York Hotel

Unexpected Water and Close Spacing Necessitated Variations from the Usual Practice for Foundations of Savoy-Plaza Hotel

FOUR different pneumatic caisson operations were employed in putting down the 105 foundation piers for the new Savoy-Plaza hotel on Fifth Ave. between 58th and 59th Streets in New York. They were necessary to meet unexpected water conditions which compelled a change from open pit excavation to pneumatic caissons. In addition there were the obstacles of a very close pier spacing, an irregular and sloping ledge to land on and an old masonry foundation mat some 10 ft. thick to be cut through. A very fast working schedule had also to be lived up to.

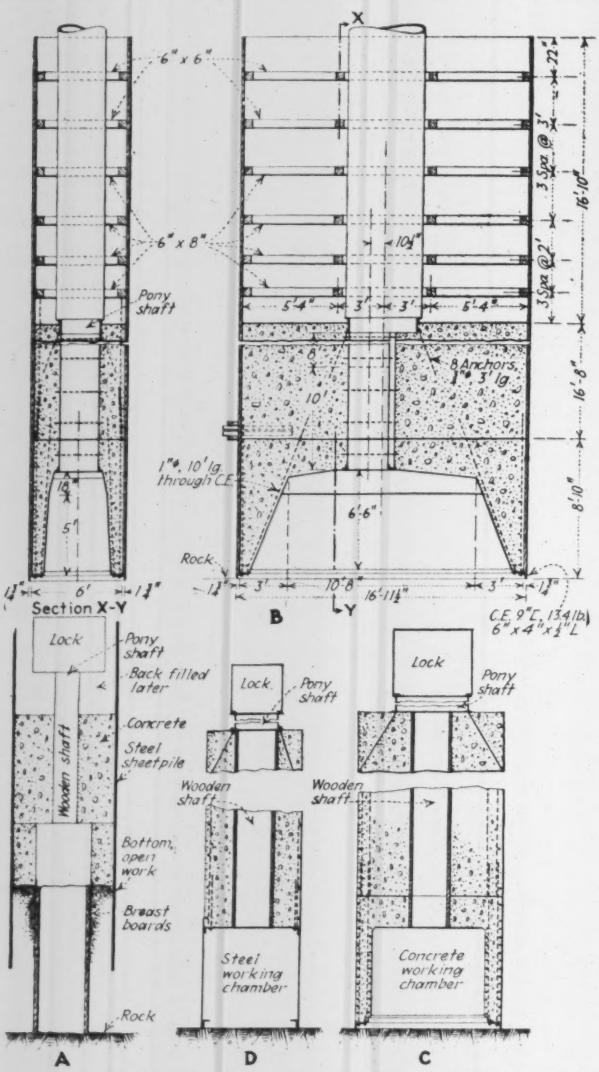


FIG. 1—DIFFERENT METHODS OF CAISSON SINKING USED AT SAVOY-PLAZA HOTEL, NEW YORK CITY

General Conditions—The site has an area about 200 x 150 ft. on which are located 105 piers. Besides 11 piers started as open excavation and changed over to air, 15 others were sunk by compressed air in a wooden sheathed concrete caisson, and 3 were sunk by the open method since rock was rather near the surface at one corner of the site. The remaining piers except two were sunk as circular concrete cylinders using a steel working chamber. A slight variation from the last method was made on two of the circular piers where a concrete working chamber was used. All muck was removed from the pier excavations by two four-boom travelers and two stiff-leg derricks.

FIG. 2—METHOD OF AIR SINKING USED WHEN SEVERAL PIERS WERE CLOSE TOGETHER

Two or three circular piers were combined as a rectangular pier and sunk inside of wood sheathing; proved a very rapid method.

Although Manhattan Island is noted for the sudden and radical changes in its geological formation, the area ordinarily requiring the use of pneumatic foundations is fairly well defined. This area includes all of the lower part of the island and a strip on each side parallel and contiguous to the Hudson and the East rivers. The mid-town section and upper end of the island, in which this foundation is located, are almost invariably suited to open pit foundation work. The contractor started with this method in mind, and partly sank eleven piers before the excessive "boils" of water and mud required a change to compressed air. This condition arose when an unexpected flow of water was struck in a stratum of disintegrated rock. This water is believed to be a subterranean stream running almost directly across the foundation area and probably emptying into the East River six or seven blocks away.

In general there were two special obstacles to caisson sinking. The close spacing of the piers, in some cases 3 ft. between edges, made the possibility of blowing-through from one to another very imminent. Any serious difficulty was averted by allowing only small variations between the pressures used in these closely spaced piers. The second obstacle was encountered in penetrating the foundation mat that had supported the columns of the old Savoy Hotel. The top of this mat formed the cellar floor. It was 10 ft. thick consisting

of 6 ft. of rubble, many of the stones being of derrick size, on top of which was 4 ft. of mass concrete. Concrete breakers and blasting were necessary to penetrate this mat.

First Pier Sinking Method—Eleven of the piers were started as open excavations by driving interlocked steel sheetpiling around the area of each and excavating inside by hand-mucking. Water was present from the first, but not in any quantity that could not be handled by the pumps. After a penetration of about 20 ft., excessive boiling of mud and water occurred, although the sheetpiling was at the time about 10 ft. deeper than the excavation. Fearing that the boiling might be undermining other parts of the work, the contractor decided to change to air.

FIG. 3 — CIRCULAR PIER SUNK BY STEEL CAISSON

Accordingly in the bottom of the steel sheeted pier shaft a concrete working chamber was poured with inside dimensions conforming to the pier dimensions which varied from 6 to 8½ ft. in diameter, shown in *A*, Fig. 1. A hole was left in the roof of the working chamber into which was fastened the steel pony shaft on top of which the air lock was placed. Besides the weight of the concrete, counterweights up to a maximum of 38 tons held the working chambers in place.

Having sealed the working chamber the piers were excavated under air to their total depth before any concrete was poured. Breast boards were placed as fast as the mucking proceeded downward. After striking rock the holes were concreted up to and including the concrete deck of the working chamber. Forms were then erected on top of the deck and the pier concreted up to grade. This method was successful but expensive.

Second Pier Sinking Method—The second method was used when two or more of the circular piers were not over 22 ft. out to out, and is shown in *B*, Fig. 1. As the first step a wooden rectangular form, Fig. 2, was erected on top of the ground around the steel cutting edge. Inside of the form necessary reinforcing steel was next placed and a concrete working chamber poured. The steel shaft and lock were placed on top as shown and the caisson sunk as usual by hand mucking under air. Enough concrete was poured to provide the required weight for sinking. The use of the wood sheeted caisson made these piers go down much faster than those where concrete was in contact with the ground. The largest pier sunk was 22 x 6 ft. and penetrated 42 ft.

Third Pier Sinking Method—The third method was that employed on the majority of the circular piers and utilized a steel caisson in the usual manner. This method is diagrammed in *C*, Fig. 1, while Fig. 3 shows a pier being sunk. Since none of these piers was very deep, they were concreted to their full height above ground before sinking was commenced. Steel forms were used on the outside and wooden forms for the central shaft. After the forms were stripped, the pony shaft and lock were placed on top of the pier shaft and sinking was started. In most cases the weight of the concrete carried the pier down as mucking proceeded but in others counterweights were necessary. The maximum weight used on any pier was 350 tons. In *D*, Fig. 1, is shown a variation in this third sinking method as used on two piers where a concrete working chamber was used instead of the steel.

Piers in Elevator Shafts, etc.—Several parts of the foundation area are to be depressed below the general cellar floor, from 6 to 24 ft. The pits thus formed are for elevator shafts, boiler room, etc. Wishing to complete his air work as soon as possible the contractor elected to sink the piers in these areas before the pits were made. Since the final elevation of the top of these piers was considerably lower than the cellar some method had to be used to keep the holes dry. The wooden cylinders shown in Fig. 4 were the solution. These were sealed into the top of the pier and all joints were calked watertight with oakum. Thus the superstructure contractor can place his steel columns in the dry and the surrounding pit can later be excavated and lined with a waterproof wall and floor.

FIG. 4—METHOD USED WHERE PIERS WERE SUNK BELOW CELLAR FLOOR FOR ELEVATOR SHAFT, ETC.

Wooden boxing kept holes watertight for steel erection until surrounding pit was excavated and lined.

The maximum pressures used in bottoming out the holes ranged from 17 to 28 lb. No trouble was experienced on any of the caissons except in sealing in a few cases. The pier cross-sections were so small that relatively minor irregularities in the solid rock surface were detrimental and some blasting was necessary in practically every pier before a satisfactory bottom could be made. All in all the methods used by the contractor, The Foundation Co., New York City, with H. W. Hanning as its superintendent, functioned very satisfactorily, two piers per day being sealed in as an average.

Twenty-Eight Papers Read Before Convention of New England Water Works Association

Twelve Papers on the Providence Water-Works, Six on Quality of Water, Six by Manufacturers—Cross-Connections Up Again

THE PROGRAM makers for the forty-fifth annual convention of the New England Water Works Association, held at Providence last week, devoted 12 of the 28 papers to the local water-works, assigned six topics to the manufacturers, and distributed the dozen remaining topics so as to add to the variety, interest and technical value of the proceedings. In point of general interest, the papers on controlling dangerous ice formations and on European water-works practice led. As an addition to technical literature, valuable to all concerned with the conservation and utilization of water as well as the study of great agencies of nature, the paper on evaporation was outstanding. Unusual in American practice, but common in England, is the provision of compensation water for stream diversion, the outstanding example of which, at Hartford, Conn., was the subject of one of the papers. Other notable papers dealt with loss of head in sand filters, advances in chlorination, recent court decisions on rate making, and laws and regulations for the sanitary protection of water supplies in New England.

Providence Water-Works—Of the dozen papers on the Providence water-works eight related to the additional water supply, now well toward completion at a cost of $21,000,000. The project is in charge of a special unpaid board of seven members, with no changes in personnel or chairmanship since the board was created in 1915. B. Thomas Potter is chairman and Frank E. Winsor is engineer of the board. The chief elements of these works are a large impounding reservoir, purification works, and a relatively short aqueduct, in tunnel and cut and cover. As to construction, one of the most interesting of this group of papers, by James V. Turner, resident engineer, told how the rock underlying the heart-wall of the earth dam was cleared of loose and partly loosened rock, blanketed with 1:3:5 concrete and grouted through holes 15 ft. apart. The grout was generally 1 part of neat cement to 10 parts of water thickened at some points to 1 to 5. Altogether, 192,000 sq.ft. of ledge were treated at an average cost of 74c. per square foot.

Infiltration tests of the 3½-mile Scituate tunnel, with a horseshoe section equivalent to a 7-ft. circle, showed a leakage of only 165,000 gal. per 24 hr. for the total length, said Richard R. Bradbury, resident engineer. Land and water takings for the reservoir, including 15,000 acres of land bought, cost nearly $7,000,000 or about a third of the entire cost of the project, according to paper of Earl C. Craig, designing engineer.

A paper on the new filtration works, by Walter W. Kittredge, assistant engineer, showed both pre-and post-aeration, the latter with the same head as that on the filter, and with an automatic compensating valve in the form of a truncated cone to maintain a uniform flow through the aerators despite the fluctuating head on the filters.

Of the four papers on the old works now supplying Providence, in use since about 1870, one by S. Frank Nolan, superintendent of distribution, contained the statement that a recent pitometer test showed no leakage in mains and only two or three in services. Valves of local make, fifty years after installation, are still giving satisfaction. Flush hydrants and lead services are used exclusively. The city pays the water department $30 a year per hydrant. Albeus P. Murray, meter superintendent, stated that 97 per cent of the services are metered. Meter rates are collected yearly, except where the annual bill exceeds $100. The city is divided into four meter districts, with the meters in each read in successive quarters. The bills are turned over to the city treasurer for collection, as are bills for new water meters and their installation. Meter repairs are made at city expense, except in cases of freezing or abuse.

Manufacturers' Papers—A new bituminous lining and covering for both cast-iron and steel pipe, the latter spun in centrifugally, was described in a paper by Benjamin Talbot, Middlesborough, England, read by John L. W. Birkinbine, Philadelphia, who has been representing the British manufacturers in this country, and who, in answer to a question from the floor, admitted "unofficially" that this is the lining which the United States Steel Corporation recently announced it had taken over for introduction in the United States. Thus far this lining has not been used in this country, but 24-in. pipe lined with it was exhibited at the recent Buffalo convention of the American Water Works Association. The lining material is described as "38 per cent bitumen and 62 per cent ground rock," the latter also described as "siliceous material." In the spinning process the bitumen comes to the inner surface leaving the latter smooth and shiny, the samples show. The outside coating, heated, is pressed on with a roller.

The evolution of the Venturi meter, and particularly its integrating and recording apparatus, was outlined by F. N. Connett, of the Builders' Iron Foundry. The vertical boom and bucket ditch digging machine of Barber-Greene Co. was described by Earle F. Lamprey. It may be used for mains, services, curbs and gutters, wire conduits and post holes. E. W. Herrmann, of the American Cast Iron Pipe Co., described the making of "Acipco mono-cast pipe," or sand-spun pipe made in a refractory mold. The progress of chlorination was outlined by William J. Orchard, of the Wallace & Tiernan Co., and the program contained a paper on "Mechanically Cleaned Sedimentation Basins for Water-Works," by Edmund B. Besselievre, The Dorr Co., Inc. A paper not on the program was read by title: "Objects of the Cast-Iron Pipe Publicity Bureau," by Thomas J. Wolfe.

Quality and Treatment of Water—Studies of the loss of head in rapid sand filters, with special references to the size of sand, were reported by R. G. Tyler, professor of sanitary engineering, Massachusetts Institute of Technology, in conjunction with Major W. A. Daniel-

son and Maurice LeBosquet, Jr., graduate students. The Committee on Scoring Water Supplies, E. Sherman Chase, chairman, reported disappointingly few responses to requests for criticisms of the score form submitted a year ago and that only 2 of 39 superintendents requested to use the form had done so, those at New Bedford and Northampton. The old form, with a few changes, was submitted for further consideration but not for adoption. The committee was continued.

In the course of a lengthy paper on chlorination studies with special reference to tastes and odors, Norman J. Howard, bacteriologist in charge of water purification, and Rudolph E. Thompson, assistant chemist, filtration plant laboratory of the water-works of Toronto, Ont., reported that, after two years of study superchlorination followed by dechlorination have been put in use at Toronto, treating 70 Imp. m.g.d. The object is to prevent tastes, attributable largely to phenol wastes. About four times the normal amount of chlorine is applied, with the use of sulphur dioxide for dechlorination. The estimated annual cost of the new treatment is $32,000, or $21,000 if used intermittently, when most needed, which is not considered advisable. One of the 12 Providence papers, already mentioned, by F. O. Clapp, assistant engineer, detailed color studies of waters tributary to the new Scituate reservoir. These showed that the water leaving a compensating reservoir was 50 per cent higher than the average inflow, indicating color addition from the unstripped bottom, which is slightly lessening from year to year.

A summary of New England laws and regulations for the sanitary protection of water supplies was presented by Warren J. Scott, director, bureau of sanitary engineering, Connecticut Department of Health. Bathing in public water supplies is prohibited in all states except New Hampshire and there is under the control of the State Board of Health. Both bathing and fishing in public water supplies, Mr. Scott said, should be prohibited. Cross-connections are prohibited in New Hampshire, except under conditional safeguards, and after Dec. 31, 1926, will also be prohibited in Connecticut, except that temporarily they may be continued if protected by double-check valves.

Cross-Connections—An extended discussion on cross-connections followed Mr. Scott's paper. It was started by S. E. Taylor, of New Bedford, who said that at the recent Buffalo convention of the A. W. W. A. he was very much in the minority in standing up for cross-connections, of which there are 60 in New Bedford, all protected by double-check valves. He thought that the engineers of the Mutual Factory Insurance Cos. ought to have a chance to present their side of the case. Mr. Burnham and another factory mutual engineer spoke up, the former declaring that of 1,000 double-check valves in use they had never had a report of a leak through both valves at the same time. C. W. Sherman, of Metcalf & Eddy, Boston, said that perfect inspection means constant inspection or electric connection to a tell tale; something may go wrong ten minutes after an inspection has been made. S. deM. Gage, engineer of the Rhode Island Board of Health, said he was unalterably opposed to cross-connections with a polluted supply. M. N. Baker, associate editor *Engineering News-Record*, mentioned some of the states in which cross-connections have been prohibited and urged that the N.E.W.W.A. fall in line with the A.W.W.A. and the Association of State Sanitary Engineers in declaring against this danger. C. M. Saville, manager and engineer of the Hartford Water Board, said that when cross-connections were abolished at Hartford, the city supplemented its fire protection to mills by putting in larger mains and more hydrants. On motion by Mr. Saville, seconded by Mr. Sherman, it was voted to ask the president, after consideration by the executive committee, to appoint a committee to consider the adoption of a resolution against cross-connections for presentation to the association at a fall or winter meeting.

Court Decisions on Company Water Rates—Under the title, "Principles of Rate Making," William M. Wherry, a New York lawyer, reviewed the court decisions on rates of private water companies handed down since Jan. 1, 1925. In 12 of 17 rate cases before utility commissions, the courts declared that valuations had been too low. Reproduction new, as a rate base, seems now to be established beyond question. The inch-mile basis of charging for public service appears to be gaining favor among the utility commissions. As to the latter, W. C. Hawley, chief engineer and general superintendent, Pennsylvania Water Co., Wilkinsburg, expressed the belief that it is an ultra-refinement, and that the straight mileage basis would do just as well.

Observations Abroad—Various observations on water-works practice, chiefly as to distribution, in England, France, Belgium and Holland, while on a recent trip abroad, were related by Charles W. Sherman. Fire hydrants of the post type were conspicuous by their absence, the only ones seen having been in the suburbs of Amsterdam. Elsewhere, so far as observed, the flush type of fire hydrant was in use exclusively. The low water consumption abroad, ranging from 15 to 35 U.S.gal. per capita, is due in part to the comparative difficulty of using water through lack of facilities; low fire supply demand and consequent small mains with smaller total length of joints needed; low pressures; and the small amount of water supplied by the municipality to industries, which chiefly have private systems.

Cast-iron pipe is almost universally employed, but in coal mining districts of Wales, where settlements are frequent, steel pipe is used. Appreciable amounts of centrifugally cast pipe are in use in London in sizes of 12 in. and less, but elsewhere Mr. Sherman did not learn of its use. Such odd sizes as 5, 7 and 9 in. are common in British practice. Cast-iron pipe has not been standardized abroad to the same extent as here. The standard adopted some 15 years ago by the British Engineering Standards Association is not universally accepted and the committee is now at work with the idea of modifying it. The London Metropolitan Water Board has never adopted this standard, but still uses its own design, a special feature of which is a plain spigot instead of one with a bead. In France the Paris specifications are in general use. These call for heavy beads on the spigot and a lead groove in the bell which is small and semi-circular, the bell itself being funnel-shaped—that is, without a shoulder. The German pattern has a plain spigot. In Belgium and Holland use is made of French, German or British pipe as they can be bought to the best advantage. In France some cast-iron pipe with steel bands shrunk on is being used—five or six such bands in a 4-m. or 13-ft. length. The two-fold object here is to enable the use of lighter pipe and to insure against large loss of water and from dam-

age to streets in case of breakage, since tests have indicated that the extent of the damage to such a pipe is a crack extending from one band to the next. The Pont-de-Mousson Foundry has sold a considerable amount of this pipe, particularly to the city of Paris. An American engineer cannot but wonder how long these steel bands would last if buried in the earth here.

The Talbot spun lining of asphalt and "ground rock" is receiving considerable favor, particularly for steel pipe. Reports are that there is no flow of the lining at temperatures up to 130 deg. Fahrenheit.

For joints in cast iron pipe, lead jute and hemp are commonly used, as here, but in London, and to some extent throughout Great Britain, lead joints are used, a ring of soft lead being inserted and calked lightly before the molten lead is poured. Clay rolls, instead of the American type of "pipe jointers," are commonly used.

Thermit for Ice Troubles—An address on "The Theory and Use of Thermit Heat Units for Relieving Ice Troubles" was delivered by Dr. T. Howard Barnes, professor of physics at McGill University, Montreal, and author of "Ice Formation." The theory rests on (1) the fact that a change of a millionth degree from 32 deg. F. is enough to cause or to stop ice formation—as has been used to prevent frazil or other ice trouble in penstocks and water-works intakes, and (2) that the heat waves liberated by exploding thermit are of the same wave length as those of the sun and (3) that they are far-reaching in both time and distance. Dr. Barnes described his ice-gorge work at Franklin and Oil City last winter, and the breaking up of icebergs near Newfoundland this summer. He suggested the use of thermit to thaw frozen mains and hydrants, and expressed a desire to co-operate with a committee of the N.E.W.W.A. in experiments on these possibilities. The meeting voted in favor of the creation of a special committee to act on Dr. Barnes' proposal to experiment on frozen mains and hydrants.

Compensation Water for Stream Diversion—An account of the experience of Hartford, Conn., some years ago, in compensating mill owners in kind for water diverted for city water supply was presented by C. M. Saville, of that city. In discussion, C. W. Sherman mentioned a somewhat similar action on the part of Fitchburg, Mass., twenty-five years ago.

Evaporation—A characteristically thorough paper by Robert E. Horton, hydraulic engineer, Voorheesville, N. Y., traced the history of the subject, criticised the various methods and formulas in use and presented a formula by the author.

East Providence Water Co.—The history and present works of this Rhode Island company were summarized by A. C. Dickerman, superintendent. The company supplies and installs all underground pipe, including the cement-lined steel services.

Canadian National Rys. Gain in Earnings

The earnings of the Canadian National Railways are showing a substantial increase. According to a statement just issued, the gross earnings for the first six months of 1926 were $120,989,008, as compared with $105,543,743 in the first half of 1925, an increase of 14.63 per cent. Net earnings were $14,856,660.52, compared with $3,742,345.83. Operating expenses were $106,132,347.47, as against $101,801,397.17.

Vary Mix Design for Concrete to Be Used at Different Ages

Tests Show Water Control Has Most Effect on Early Strength and Fine Aggregate Control Most Important for Ultimate Strength

By R. T. Giles

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ONE of the main considerations in designing concrete mixes—how soon the concrete will have to carry its maximum load—has in the opinion of the author been given very little thought. Methods of designing mixes which would be highly undesirable for concrete which is to be used at a given age, say seven days, might be very desirable on work which would not be used until twenty-eight days or two months.

The opportunity presented itself this year to make a direct comparison on two jobs of identical conditions using strict control on one and allowing the other to proceed under normal conditions. Two bridges were to be built using a number of precast reinforced-concrete piles. Both contracts were secured by one firm. The contractor in ordering his materials bought for both jobs at the same places and had the materials shipped at the same time. In fact, it has never occurred in my experience where conditions were as nearly the same as on these two jobs.

TABLE I—STRENGTHS OF FIELD CONCRETE FOR CONTROLLED AND UNCONTROLLED DESIGN OF MIXES

Materials and Water Controlled, Job A				Normal Volumetric Proportioning No Control of Water, Job B			
7 Days	28 Days	Per Cent Increase	28D / 7D	7 Days	28 Days	Per Cent Increase	28D / 7D
2,210	3,532	59		955	2,366	147	
2,065	3,881	87		995	2,360	137	
2,385	4,172	74		1,454	2,893	98	
2,518	4,074	61		1,468	3,815	97	
2,738	4,199	53		1,562	3,819	144	
2,566	4,022	56		1,290	2,917	126	
2,272	4,010	76		1,162	2,707	132	
2,325	3,869	66		1,066	2,346	120	
2,119	3,842	81		1,729	3,651	111	
1,787	3,502	96		1,320	3,179	140	
2,298	3,910	70		1,300	3,005	131	
7 days—53 per cent variation low to high.				7 days—81 per cent variation low to high.			
28 days—19 per cent variation low to high.				28 days—61 per cent variation low to high.			

NOTE:—1.85 bbl. cement to 1 cu.yd. concrete; Each value average of 3 specimens.

Since ¾-in. maximum size gravel was used for coarse aggregate, 3-in. x 6-in. cylinders were adopted as the standard-size specimen. Precautions were taken to see that the same percentage of cement per unit volume of concrete was used on each job. Specimens were broken at 7 and 28 days and others will be broken at one year. On the job where everything was controlled the amount of water was set at 5¾ gal. per sack of cement with a maximum of 6 gal. On the other job the water varied from time to time, and was known to have been as high as 8 gal. per sack of cement. The appearance of the piles after casting was very good in each case.

When the 7-day results were recorded, as shown in Table I, a very decided difference in strengths was noted. On the controlled concrete, Job A, the strengths were 77 per cent greater than on the job that was not controlled, Job B. Another very notable feature was that the variation in the strength of the concrete was

much greater where the concrete was not controlled than where it was.

When the 28-day strnegths were recorded the results seemed to have changed considerably. Instead of the Job A concrete being 77 per cent stronger, as it was at seven days, it was only 30 per cent stronger. All specimens were cured exactly alike, so the cause for this extra increase in strength of the wet specimens must have been internal. Another fact noted was that the variation in strength had narrowed down considerably. The average increase in strength can be noted in Table I. The question arises as to whether the strength of the normal concrete will overtake the strength of the controlled concrete and, if so, how soon.

In order to check the field conditions a series was run in the laboratory in which 21 graduations of sand were used. The sand was separated into the following sizes: 0 to 30, 30 to 16, and 16 to $\frac{3}{8}$, and recombined so that the resulting fineness moduli were as shown in Table II. Coarse aggregate was omitted so that the unmeasurable workability feature of concrete would be reduced to a minimum. In one set the amount of water used was determined by the flow table. In the other set gradation number 16 was taken as a standard and the water used in that was used with each of the other

TABLE II—STRENGTH RESULTS OF 21 GRADATIONS OF SAND TESTED IN 2 x 4 MORTAR CYLINDERS AT 7 AND 28 DAYS

Grad. No.	Water, Gal. per Bag	Comp. Strength 7 Days	Comp. Strength 28 Days	Per Cent Increase 28D/7D Dry	Per Cent Increase 28D/7D Wet	Fineness Modulus
1	7.25	1,236	2,148	..	73	4.53
1	5.62	1,621	2,400	48		4.53
2	7.25	1,399	2,671		90	3.74
2	5.81	1,763	2,419	37		3.74
3	7.25	2,028	3,276		61	3.76
3	6.08	2,138	3,157	47		3.76
4	7.25	1,583	2,777		75	3.66
4	5.99	1,847	2,563	38		3.66
5	7.25	2,093	3,238		54	3.50
5	6.37	2,460	3,634	47		3.50
6	7.25	2,002	3,234		61	3.26
6	6.74	2,428	3,635	49		3.26
7	7.25	1,487	2,500		68	3.32
7	6.46	1,893	2,519	33		3.32
8	7.25	1,852	3,107		67	3.07
8	6.64	2,170	3,275	50		3.07
9	7.25	1,951	3,068		57	2.78
9	6.83	2,089	3,248	55		2.78
10	7.25	1,682	2,760		64	2.54
10	7.02	1,824	2,890	58		2.54
11	7.25	1,605	2,463		53	3.04
11	6.37	1,717	2,560	49		3.04
12	7.25	1,735	2,721		56	2.90
12	6.64	1,769	2,682	51		2.90
13	7.25	1,788	2,757		58	2.43
13	7.02	1,778	2,656	49		2.43
14	7.25	1,553	2,485		60	2.36
14	7.30	1,570	2,521	60		2.36
15	7.25	1,384	2,175	57		2.04
15	7.96	1,308	2,188		64	2.04
16	7.25	1,303	2,115	62		2.83
16	7.25	1,303	2,115	62		2.83
17	7.25	1,430	2,252		57	2.46
17	7.21	1,573	2,331	48		2.46
18	7.25	1,468	2,066	40		2.31
18	7.67	1,465	2,224		51	2.31
19	7.25	1,425	2,240	57		2.05
19	7.96	1,318	2,083		58	2.05
20	7.25	1,275	2,041	60		1.78
20	8.19	1,160	2,053		76	1.78
21	7.25	1,319	1,830	38		1.54
21	8.67	960	1,737		80	1.54
Average				48	64	

NOTE:—Each result is average of 6 cylinders; all specimens cured in damp room until tested; 25 per cent cement.

gradations. The 7-day strengths in every case showed the drier mixes to be the stronger. At 28 days a number of the wet mixes had obtained the same strength as the drier mixes and, in every case except one, had shown a greater percentage of gain in strength. The same question might be asked again—Will the wet mixes become stronger than the dry mixes and, if so, when? One year specimens will be broken in this series also.

Another point of interest in this series is a comparison of gradations which have approximately the same fineness modulus and with which was used the same amount of water per sack of cement. Such a comparison is shown in Table III.

Conclusions—There seems to be a very decided advantage in accurate control of the materials and the

TABLE III—STRENGTH COMPARISONS AT 7 AND 28 DAYS OF 2 x 4 MORTAR CYLINDERS HAVING SIMILAR FINENESS MODULUS

Grad. No.	Fineness Modulus	Water, Gal. per Bag	Compressive Strength 7 Days	Compressive Strength 28 Days
2	3.74	7.25	1,399	2,671
3	3.76	7.25	2,028	3,276
8	3.07	7.25	1,852	3,107
11	3.04	7.25	1,605	2,463
9	2.78	7.25	1,951	3,068
16	2.83	7.25	1,303	2,115
13	2.43	7.25	1,738	2,757
17	2.46	7.25	1,430	2,252
14	2.36	7.25	1,553	2,485
18	2.31	7.25	1,468	2,066
15	2.04	7.25	1,384	2,175
19	2.05	7.25	1,425	2,240

water at the 28-day period, especially in such cases as these piles when the most severe use will be in the driving at an early age.

Several conclusions seem to be brought out in these comparisons: (1) The fineness modulus is not a true measure of gradation but an indication only; (2) the accurate control of water has a much more decided effect on the early strength than on the later strength of concrete; (3) for ultimate strength accurate control of the fine aggregate is of much more importance than accurate control of the water.

Ohio Constitutional Amendment Defeated

The proposed amendment of the constitution of Ohio authorizing municipalities to assess upon property benefited by any public improvement the cost of purchasing property for the improvement was defeated by popular vote on Aug. 2. The amendment would have permitted the assessment of the whole or any part of such purchase cost "upon property benefited by the improvement whether abutting, adjacent or otherwise located," but in no case could the assessment exceed the "special benefit conferred thereby." Editorial comment on the proposed amendment, published in our columns of July 15, p. 85, was written on the understanding that the amendment applied to the entire cost of certain public improvements instead of to land acquisition only. We are informed by F. H. Waring, chief engineer, Ohio State Department of Health, that under Sec. 3819 of the General Code of Ohio, benefit assessments may be levied for certain public improvements provided that within a period of five years the total of such assessments does not exceed 33⅓ per cent of the actual value of the property after the improvement is made; and with the further proviso that assessments for the construction of main sewers "shall not exceed the sum that in the opinion of council would be required to construct an ordinary street sewer or drain of sufficient capacity to drain or sewer the lots or lands to be assessed for such improvement, nor shall any lots or lands be assessed that do not need local drainage or which are provided therewith."

From Job and Office

HINTS THAT CUT COST AND TIME FOR THE CONTRACTOR AND ENGINEER

Device Guides Torch in Cutting Pipe on True Bevel

AN adjustable device to hold an oxyacetylene torch in a position such that when rotated it makes a true bevel cut at any desired angle with the pipe center line is used on the pipe being laid on the 26 to 30-in. steel supply line by the Marin Municipal Water District, California. All field joints are welded. Bends occur at four out of five joints on most of the line. The device shown in the illustration was therefore developed to facilitate making the angular cuts for these bends.

The device is of two parts; the part that goes in the pipe first is a spider or framework of three arms arranged as spokes around a hub. Into this hub is inserted a shaft carrying the second part which consists of the torch support, the angular setting and the rotating mechanism. One of the spokes of the spider is of adjustable length and after insertion in the pipe this spoke is lengthened to tighten the steel points of all three spokes against the inside of the pipe.

BEVEL CUTTING DEVICE READY FOR OPERATION

The spider is set each time the same distance from the end of the pipe by the aid of a flexible steel runner or guide, fastened near the outer end of each spoke. These runners carry small metal blocks at equal distances from the spokes and thus when the blocks fit snugly over the edge of the pipe all three spokes are in a plane normal to the center line. When the spider is fastened firmly in place these runners are easily swung out of the way because they rotate on the collars by which they are fastened to the spokes.

The hub is accurately centered in the spokes, and into the hub is inserted the shaft carrying the mounting for the torch. This mounting is on a pivot with a protractor for setting angles and a crank-driven worm gear with which the torch can be rotated. Thus at each bend one-half the desired angle is set off on the protractor, the shaft is clamped in position and the torch rotated in a vertical plane. As the axis of the ellipse lengthens while the torch is being rotated, the cutting tip is advanced radially by rotating a knurled sleeve in the handle. The operator rotates the torch slowly with one hand while the other moves the knurled sleeve that keeps the tip at the proper distance from the plate to be cut.

With this device there is practically no more trouble in cutting bevels than in cutting square joints. Since the bends in the line are so frequent the practice is to use this cutting device in every end, whether the joint is on tangent or at an angle. In this way a uniform bevel is obtained on all joints, which materially improves the quality of welds. Whether square or at an angle the torch is held by the mechanism in a true vertical plane and hence the cuts are extremely accurate.

The device was developed and a patent has been applied for by Hugh F. Brown, of Brown Brothers Welding Co., which holds this welding contract.

Slide Rule for Submerged Orifices and Cipolletti Weirs

BY H. K. SMITH
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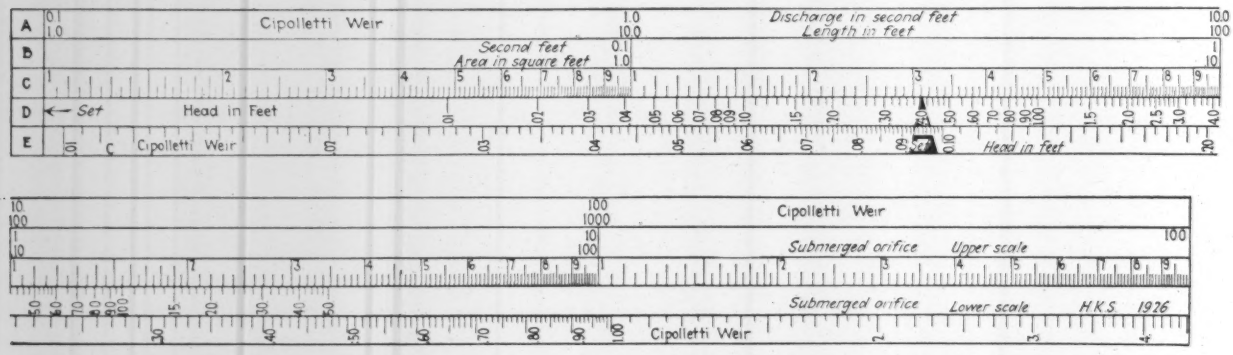
ON the Klamath Project of the Bureau of Reclamation, with headquarters at Klamath Falls, Ore., the daily water deliveries are measured by submerged ori-



SLIDE RULE FOR COMPUTING DISCHARGES OF SUBMERGED ORIFICES AND CIPOLLETTI WEIRS

fices and Cipolletti weirs. The time and labor required for these computations have been materially lessened and the required accuracy maintained by the use of a special slide rule.

In the accompanying figure scales *A*, *B* and *C* are the upper slide and scales *D* and *E* are the lower slide (corresponding to scales *D* and *C*, respectively, of the Mannheim rule). Scales *A* and *B* simply denote the position of the decimal point on scale *C* for the different denominations. Scale *C* is a logarithmic scale with a 10-in. base, and is used for the area of the submerged orifice and the length of the Cipolletti weir with the corresponding discharges in second-feet. Scale *D* is a logarithmic scale to a 5-in. base to denote head on the submerged orifice, the set being at the extreme left as shown by the arrow. Scale *E* is a logarithmic scale to a 15-in. base to denote head on the Cipolletti weir, the set is shown at the wedge at 0.095.

The construction of the rule is simple. The scales are drawn on tracing cloth, as shown, and to the bases named. Prints are made and cut along the line between scales *C* and *D*. The portion carrying scales *A*, *B* and *C* is pasted on one rule and the remainder carrying scales *D* and *E* is pasted on another rule. The "set" point on the scale of head is set to the desired area of orifice or length of weir and the discharge read on scale *C* above the proper head.

Bitumen Determinations In Coarse Asphaltic Concretes

By A. R. Ebberts
Chemist, Department of Public Works, Allegheny County, Pittsburgh, Pa.

In the routine control of coarse asphaltic concretes considerable trouble is experienced due to the difficulty of obtaining truly representative samples without exceeding the capacity of the extractors usually used for this purpose. A single extra large stone, or two or more smaller ones will completely ruin the results, making the sample appear lean; a stone or two too few will have a similar effect in the opposite direction. However, if mixing has been properly carried out, the bitumen-superficial area relationship is constant throughout the mixture and will so appear in any sample, within the limits of accidental variations of aggregate sizes in sampling.

L. N. Edwards, in his paper on the proportioning of portland cement mortars and concrete (*Proceedings*, A.S.T.M., Vol. XVIII, Part II, 1918), reports the results of an immense amount of painstaking work on the superficial areas of aggregate particles. His procedure was as follows. He separated sand into gradings passing and retained on various-sized sieves in the ordinary manner. He then actually counted the number of particles in weighed portions of these gradings. With the number of particles per gram known and the specific gravity of the material also known, he was in a position to calculate the average size and superficial area of all particles concerned. He assumed in his calculations that particles of sand and gravel were spherical while those of broken stone were one-third cubes and two-thirds parallelopipeds with sides 1:2:2, resting his justification for these assumptions on actual counts and measurements. He was then able to draw a chart illustrating graphically the relationship between weights and superficial areas of the various gradings with which he was concerned.

Following the above procedure of Edwards as to calculations, the author made up a similar chart for the sizes of particles into which aggregates are divided in the Allegheny County asphalt laboratory. A skeleton fac-simile of this chart is illustrated. It is in daily use and has proved its value. In preparing such a chart for control work the individual curves must correspond to the sieve sizes used in the sieve analysis of the aggregate after extraction. The latter should follow the specifications for the material being analyzed. The total retained on the ½-in. screen is used in conjunction with an average curve for such material drawn on the chart because these larger particles have so little superficial area per gram in com-

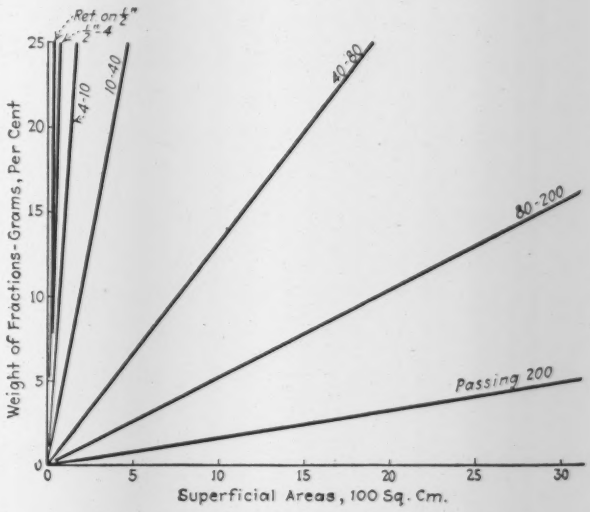


CHART FOR DETERMINING BITUMEN IN COARSE ASPHALTIC CEMENTS

parison to the smaller ones that further separation is waste of time as far as this correction is concerned. Applying the curves to the ideal grading as determined by the specifications we read off the superficial areas corresponding to the average specified amounts of each size, interpreting percentages as grams in one hundred grams of mixture. Adding these gives the total superficial area of all particules in the aggregate. Dividing the amount of bitumen specified (again regarding per cent as grams per hundred) by this total area in hundreds of square centimeters gives us a bitumen-superficial area ratio for the particular mix involved, which we will hereafter for convenience call the bitumen index of the mixture.

The chart and the bitumen index are all that is required to determine whether or not any sample meets specifications as far as the bitumen content is concerned It is only necessary to apply the curves to the percentages of each grading, as found by sieving after extraction, and add the areas obtained. Multiplying this sum by the bitumen index gives the amount of bitumen required for the particular sample of aggregate. Comparison of this required figure with that actually found by extraction permits several valuable deductions. If the extraction figure is low it means either that the proper amount of asphalt cement is not

being weighed into the mix or that the aggregate is in general finer than the designer intended. If it is high, too much asphalt is being used or the aggregate is too coarse. After satisfying himself that the proper amount of asphalt cement is being used the control expert should scrutinize carefully made sieve tests of the aggregates before and after mixing to find the explanation and remedy for his troubles. Since much larger samples can be sieved than it is practicable to extract, representative results are easily obtained and the trouble located.

The method may seem cumbersome to the reader but the author makes these corrections daily as a matter of routine. They take consistently less than two minutes each by actual timing.

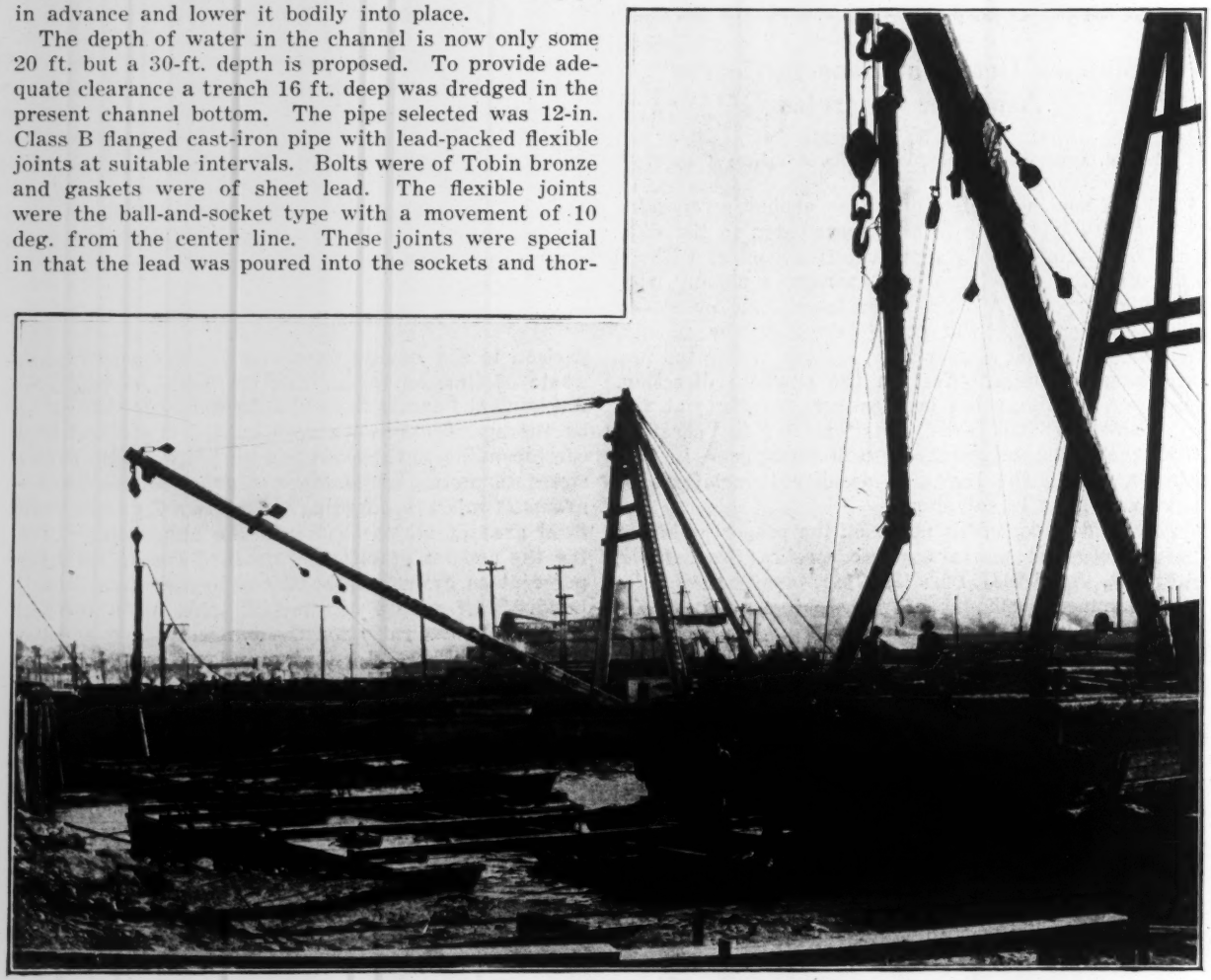
Assembled 12-in. Pipe Lowered as Unit in Navigable Waterway

TO IMPROVE interconnection conditions in its distribution system, the Spring Valley Water Co. of San Francisco recently laid a 12-in. main across Islais Creek, a ship channel about 200 ft. wide on San Francisco Bay in the southern part of the city. Conditions were such that it seemed advisable to assemble the pipe in advance and lower it bodily into place.

The depth of water in the channel is now only some 20 ft. but a 30-ft. depth is proposed. To provide adequate clearance a trench 16 ft. deep was dredged in the present channel bottom. The pipe selected was 12-in. Class B flanged cast-iron pipe with lead-packed flexible joints at suitable intervals. Bolts were of Tobin bronze and gaskets were of sheet lead. The flexible joints were the ball-and-socket type with a movement of 10 deg. from the center line. These joints were special in that the lead was poured into the sockets and thoroughly hammered to force it slightly into the space to be occupied by the ball end of the joint. The lead filling in the sockets and hold-on ring was then machined to the exact spherical shape of the ball to be fitted. These joints are reported to be absolutely tight under 65 lb. pressure and to have remained tight after any movement of the joints incidental to laying the main.

That part of the pipe line which lay horizontal was first assembled on pontoons along the wharf line. This was done by suspending the main between floats where it was held in place by rope slings fastened to the pontoon stringers, so that the entire section was at all times above the water. One end of the rope sling was made fast while the other end could be paid out, the length of the rope being at least twice the water depth.

After the horizontal section of the pipe line was assembled, it was floated across the channel directly over the trench into which it was to be laid. The ver-



SUBMARINE PIPE ASSEMBLED READY FOR LOWERING

This view shows the vertical portions bolted on to the horizontal portion, which was not done until the latter was floated to place.

From Job and Office

HINTS THAT CUT COST AND TIME

From Job and Office

FOR CONTRACTOR AND ENGINEER

tical sections of the main were then swung into place and held in the vertical position by means of derrick barges, and fastened to the horizontal section. The height of these vertical sections was such that when the main was lowered into place the ends would project above water. Bends making an angle of 45 deg. were used to bring the ends of the pipe line to the desired location.

While the main was being held above water, blind flanges were placed on the ends. The line was then filled with water and subjected to a pressure of 65 lb. per sq.in., which is the standard for the system.

With the full pressure on the line, the main was carefully lowered 1 ft. at a time, the rope slings supporting the pipe line having been carefully marked for this purpose. When within 2 ft of the bottom of the trench the alignment of the pipe line was carefully checked and it was then lowered into final position.

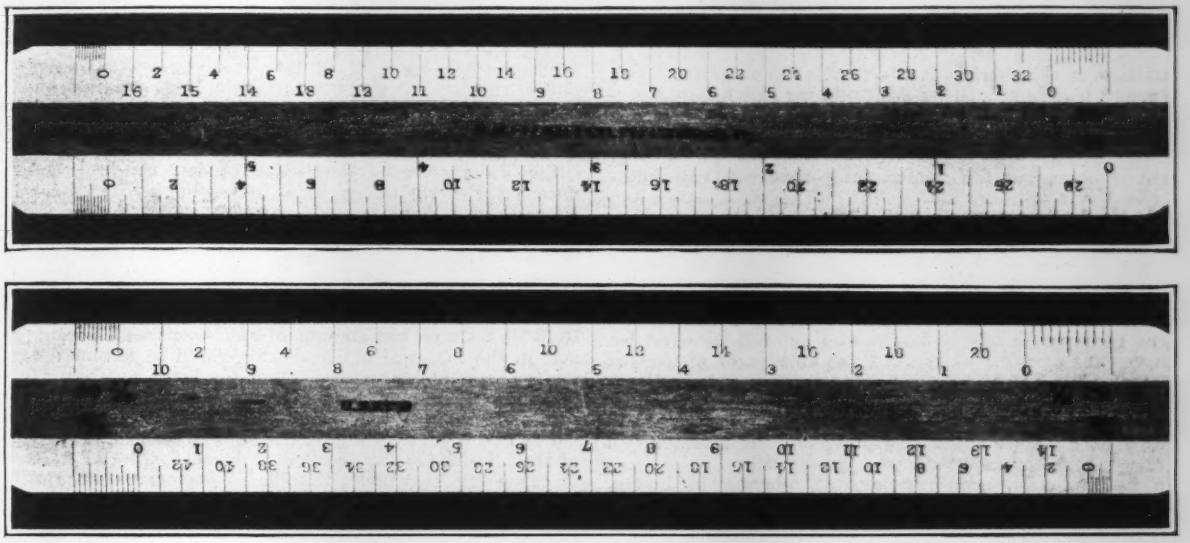
No attempt was made to backfill the trenches. It was found by soundings taken two weeks after the main was lowered that it was covered with mud for about half the depth of the trench. Connection of the submarine pipe line to the system could then be made, it was believed, without danger that further settlement would materially affect conditions.

Just before the Islais Creek work was undertaken a similar job was done in crossing a 160-ft. channel at 4th St. To the experience with difficulties in that earlier work is ascribed, in part, the success of the Islais Creek job. In addition to an opportunity to try out the most serviceable gear and tackle, the earlier job showed the desirability of casting in one piece the ring which holds the ball of the ball-and-socket joint in place. In order that this could be done, the flange and the ball were not cast in one piece; instead, the flange was designed to be screwed on after the hold-on ring was in place and then pinned so it could not unscrew. Another important point was in keeping the line under full pressure during lowering and until all settlement had taken place. This held the ball-and-socket joints tightly in their normal position and thus avoided leaks due to the slight changes that occur when pressure is put on a line which has been put into place without it.

The contractor was the American Dredging Co. Engineering work on the job was done by O. G. Goldman, assistant superintendent, city distribution, Spring Valley Water Company.

Combined Engineers' and Architects' Scale Proves Useful

WORK on bridge and other engineering plans in the office of V. R. Covell, county engineer of Allegheny County, Pittsburgh, required frequent alternation between engineers' scales (decimal divisions of fraction of an inch) and architects' scales (fractions of an inch divided into twelfths). The usual forms of scales available in the market carry either the one kind or the other. Mr. Covell therefore arranged a double-edge flat scale, whose four ruled edges provide eight separate scales, as shown in the photograph.



SIX-INCH COMBINED ENGINEERS AND ARCHITECTS SCALE
Eight scales are available on the four ruled edges of this instrument.

A number of such scales have been made for the Department of Public Works of the county by B. K. Elliott Co., of Pittsburgh, and are proving very convenient in the work of the department.

Job and Office Notes

Rock Spreaders Attached to Trucks were used by the California Highway Commission on an asphalt macadam surfacing job recently completed in District VI. The macadam surfacing was placed to improve the concrete base which was broken and uneven. A frame extension with a tail gate regulated by a long hand lever was built for each truck. One man rode each truck and regulated the flow of the material. The truck backed over the material as spread to avoid picking up or roughening the oiled sub-base.—*California Highways.*

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

On Computing Shrinkage in Earth-Fill Dams

Sir—All searchers for data on shrinkage in earthen dams, both hydraulic-fill and those built in layers, seem to have encountered the same lack of evidence mentioned in your editorial of Sept. 9, p. 407.

What we really wish to determine is the volume between the foundation surface under the dam as cleared ready for placing the fill and the finished surfaces of the structure, and the volume relation to material in borrow pits or the looser materials in cars or wagons. That this information is not more readily available is due to the fact that the earth in dams is paid for in place and not in borrow.

It cannot be assumed that the foundation surface remains where located by the cross-sections taken previous to construction. We build earthen structures on foundations ranging from solid ledge rock to mud flats and swamps, unyielding in the first instance but permitting total disappearance of a fill overnight in the latter.

Earth dams are not built on too yielding foundations. That there is compacting of the foundation material under the heavy loads imposed by dam fills we can hardly question; the amount of it is a function of the depth of the underlying material and varies with its character. It is probably slight in amount compared with the volume and height of dam, but the fact remains that we know nothing about it.

Such records as that of the Miami Conservancy hydraulic-fill dams which showed settlements or shrinkage of 0.33 to 0.5 per cent of their vertical height, or the Somerset semi-hydraulic-fill dam which settled about 0.4 ft. in its 100-ft. height, or that of a dam in Indiana, placed in layers, which settled an average of 0.54 per cent of its height in a period of 4.4 months, do not tell us what we really wish to know. They show the amount of settlement that took place *after* the structures were completed. Their value is that they indicate very compact material in the dams and that there is no necessity for over-fill in structures built in this manner—certainly not the classical "10 or 12 per cent" of railroad and highway fills.

In hydraulic-fill, semi-hydraulic-fill, placing in layers, puddling or irrigating methods, the materials are being compacted as placed, and in all of them settlement occurs as the overburden increases, and to some extent after completion of fill, as shown by settlements above mentioned. It is this total compacting of material going into a structure plus the displacement caused by settlement of foundation material that we wish to compare with borrow pit or car quantities.

The only way this can be determined is by borings made in the fill after completion as has been done by railroad valuation engineers or, what would be more accurate, the burying and careful location of metal plates in the fill as it progresses, beginning on the foundation surface and at varying intervals of elevation and location. Borings and measurements to the plates in the completed structure would give accurate information of progressive and final settlement.

The nearest approach we have at present to the information desired is of the character given by L. A. Sumner in *Engineering News-Record*, May 27, 1926, p. 872; "Shrinkage of Earth in a Dam," by R. M. Hosea in *Engineering and Contracting*, April 1, 1908; Burr Bassell in his book on earth dams; and J. D. Schuyler in "Reservoirs," pp. 115-124. Only one of these has to do with hydraulic-fill that by Schuyler.

Another method would be to determine the dry weight per cubic foot of compacted material in the dam and of the same material in the borrow pit and from these the change in volume between pit and fill. But it must be remembered that in borrow pits, surface, subsurface and deeper materials vary in compactness and therefore in weight and again vary in weight as their composition and particle sizes vary.

This method would be difficult of execution because of the inability to secure samples from the interior of the dam and therefore a lack of knowledge as to its composition and with what borrow pit material it should be compared, nor does the method tell us anything of the amount of compacting of the foundation material.

Railroad engineers knew that large displacements and settlements were taking place under and in their fills but I think the amount and extent of it came as a surprise when a few years ago borings and investigations were made to determine the cost of replacement of fills.

The percentages of settlement or compacting that takes place from borrow pit to fill in the construction of an earth dam are as great or greater than have been determined and recorded many times for railroad fills. Of that we can be certain. The character and behavior of the materials used in railroad fills in the past have not changed from those used in earth dams in more recent years. The only difference is that for dams, selected materials have been used and methods of placing employed that brought about greater consolidation in shorter time.

Percentages of settlement or shrinkage are given by the above mentioned authorities. Gillette in "Earthwork and Its Cost," Chap. I, has collected much information on the subject of earth shrinkage, and interesting data are given in *Transactions*, Am. Soc. C. E., Vol. LXXXV, p. 1,220.

Percentages have not been quoted by the writer for the reason that all the circumstances under which results were obtained should be known to those proposing to make use of the data, therefore it is left for them to consult the authorities.

J. ALBERT HOLMES,
Hydraulic Engineer.

Newfoundland, N. J.
Sept. 12, 1926.

Sir—In answer to your editorial deploring the lack of data on the shrinkage in a hydraulic fill (*Engineering News-Record*, Sept. 9, 1926, p. 407) the following should prove of interest.

It is obvious that any settlement in a hydraulic fill is either due to the compressing or displacing of the soft material under the fill or else to the compressing which takes place in the material that is pumped into place. Reliable data on the amount of settlement which would result in the material under the fill would be a very difficult matter to establish on account of the large number of contributing factors such as (1) depth and character of the soft material, (2) the amount of vegetation such as grass, weeds and trees growing on the area to be filled, (3) height of the fill and (4) the chances of the soft material to escape or creep out from under the fill. However, as to the settlement which occurs in the pumped material very definite factors within reasonable limits would more than likely result were all the available information investigated.

In the past eight months we have filled with a hydraulic dredge approximately 30 acres of cypress swamp on the shore of Lake Okeechobee at the head of the St. Lucie Canal. A cross-section of the area filled gives the following elevations (Gulf Datum): Rock elevation 10—this is a hard limestone rock, on top of which is sand up to elevation 14 or 15, and on top of the sand is muck up to elevation 18. The elevation of the lake varies between 16 and 18. The muck is covered with a dense growth of tropical underbrush, maple trees and large cypress trees. Before filling the area is diked off with a spoil bank of ample cross-section with a spillway cut in one end to allow drainage. Elevation of completed fill is from 30 down to 22.

For measuring the settlement nails were driven in trees and in two instances pipes were driven down to bedrock. Thus there was no possibility of the bench mark settling with the fill.

In every instance the settlement was negligible and in no case exceeded 0.5 per cent. The material pumped was about half muck and half sand. Some of the muck mixed with the sand but a large percentage of it would be displaced ahead of the sand. This would collect in pockets throughout the fill, necessitating repumping in these places. No effort to measure settlement in these pockets was made.

A few soil tests to determine the bearing value of the fill were made. These may be obtained from the writer should anyone be interested. They are not sent for your publication as their value is probably limited to this particular fill.

FLOYD FERRIS,
Resident Engineer,
Mayaco Co.

West Palm Beach, Fla.,
Sept. 15, 1926.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Tropical Hurricane Wrecks Southern Florida

130-Mile Gale Cuts 60-Mile Swath Across State—Structural Damage Not Yet Reported

On Saturday, September 18, a tropical hurricane originated in the Carribean Sea, and covering a path about 60 miles in width, hit the east coast of Florida with its center somewhat north of Miami, and taking a northwesterly course, carried its path of destruction through the state over the northeastern section of the Gulf of Mexico and hit the Gulf Coast of Florida at Pensacola. The storm dissipated itself on September 22 northwest of Mobile. Damage to structures in the affected section was very great. Hundreds of people were killed and many more were injured. Overhead wires were so badly broken as almost completely to destroy communication so that when this is written, (September 22) reports are still so vague and conflicting as to make any statement as to the extent of damage untrustworthy. It is apparent, however, that the destruction of smaller residential structures was very great and that the damage to what might be called engineering structures lay almost entirely in superficial damage such as breaking of windows, cornice removal, etc. There are, however, reports of serious structural damage to some steel frame buildings on which further data will be required.

The major part of the damage was in the city of Miami, which apparently received the center of the storm force. Hollywood and Ft. Lauderdale, respectively 18 and 45 miles north of Miami, were also hard hit. In the center of the state the new town of Moore Haven on the southwest shore of Lake Okeechobee, was overwhelmed with a flood caused by the break of the levees which had been built along the south end of the lake as a part of the reclamation scheme which the state is carrying on to drain the Everglades. The west coast apparently did not suffer as much damage as the east and confusing reports indicated that Pensacola and Mobile while suffering some damage from the storm were not seriously affected.

Boston Indictment Charges Three with Paving Fraud

On September 11 the Suffolk County grand jury brought in an indictment charging conspiracy on five counts against Joshua Atwood, engineer in charge of the Highway Division of the Public Works Department of the city of Boston, and the Warren Brothers Company and the Central Construction Company. One of the counts charges that the parties named "did combine, conspire, confederate and agreed with each other, knowingly and designedly, to fix, establish and maintain for the sheet asphalt manufactured by the Central Construction Company a price so exorbitant, excessive, unfair and unreasonable as to result in the exclusive use by such persons or corporations as might contract to lay and construct bituminous pavements for the city of Boston, and to attain, create and maintain a monopoly for Warrenite bitulithic under an exorbitant, excessive, unfair and unreasonable price to the detriment of the city of Boston and the public in general."

The accused at once made a plea in abatement of the indictment on the ground that the grand jury was improperly influenced by District Attorney O'Brien, who is candidate for re-election in January, and that at least two members of the grand jury which returned the indictment entered upon their duties as jurors after the jury had been hearing the evidence upon which the indictment was returned. The plea was not granted and the defendants have been arraigned.

To Report Structural Damage of Florida Hurricane

F. E. Schmitt, Associate Editor of *Engineering News-Record*, left on Tuesday for the south of Florida. He will investigate the effect of the hurricane of Sept. 18-19 on engineering structures and will report them in a series of articles to be published as soon as the study is completed.

New England Water-Works Men Convene in Providence

Committee on Co-operation with A.W.W.A. Proposed—F. E. Winsor Chosen President

Appointment of a committee to consider co-operation with the American Water Works Association, suggested in a seemingly casual way at its very close, was the most notable feature of the brief informal presidential address of Theodore L. Bristol, president of the Ansonia Water Co., deferred to the last moments of the forty-fifth annual meeting of the New England Water Works Association, held last week at Providence. Not over fifty members were present at the time. There was no discussion of the proposal. Among the year's doings spoken of by Mr. Bristol was a questionnaire on salaries of water-works men, sent out recently. Returns thus far show increases in various classes between 1914 and 1926, some of which are: Registrars and chief (pumping?) engineers, 50 per cent; superintendents, 62; laborers, 108 per cent.

Only 299 valid ballots were cast for the election of officers, mostly unanimous for the various candidates. Frank E. Winsor, chief engineer, Providence Water Supply Board, who takes up a similar position Oct. 1 with the construction commission for an additional supply for Boston and vicinity, was elected president, and Arthur D. Weston, principal assistant engineer, Massachusetts State Board of Health, vice-president.

Brackett Medal Awarded

The Dexter Brackett medal for 1925 was awarded to John F. Laboon of the J. N. Chester Engineers, Pittsburgh, Pa., for his paper on The Filtration Plant of Wheeling, W. Va., printed in *Journal* N.E.W.W.A. for December, 1925.

The total membership of the association on Sept. 1, according to the report of Frank J. Gifford, secretary, was 744, a net loss for the year of 7. During the year, $5,000 was added to the permanent investment fund, bringing it above $13,000.

Provision was made for committees to report on the advisability of adopting a resolution on advocating the abolition of cross-connections and to co-operate with Dr. T. Howard Barnes, of McGill University, Montreal, on the use of thermit to thaw frozen mains and hydrants. A progress report on a sanitary score system for water supplies was the only committee report submitted during the convention.

An inspection trip to the new impounding reservoir and filtration plant of Providence was made Thursday afternoon. This was followed by a Rhode Island clambake, a "unique entertainment" and a dance at Chopmist

Inn, Scituate, given by the Water Works Manufacturers' Association. The association also gave a dance Tuesday evening and a ladies' theater party Wednesday evening. The Builder's Iron Foundry, other manufacturing plants and some of the Providence parks were visited Wednesday afternoon.

A report of the technical proceedings appears on p. 508 of this issue. A list of the exhibitors of water-works materials and appliances appeared on p. 358 of our issue of Aug. 26.

U. S. Government Loses Again in Cantonment Suit

The United States Circuit Court of Appeals in St. Louis, Sept. 16, ruled against the United States Government in its claim for $3,000,000 against the George A. Fuller Company of New York, the contracting firm that constructed the wartime cantonment at Camp Funston, Kan.

In its suit the Government alleged that the cost of the cantonment, $8,766,985 was $3,000,000 in excess of the reasonable and proper cost, and that the excess was due to the failure of the contractors to provide the proper plans, system and methods of construction.

The Kansas district court had held that the contract was faulty in that it failed to specify the things that the Government wanted done.

This is the fourth time that the Government has lost in this case.

Favorable Report Made on Owyhee Irrigation Project

Without making any prediction as to when the new Owyhee project will repay its construction cost, R. F. Walter, the chief engineer of the Bureau of Reclamation, foresees a bright future for the enterprise. Among other things he says:

"The project will cost in round numbers $18,000,000 or an average of approximately $150 an acre. This is a high acre cost when compared with many of the constructed projects, but none of the projects of the future will be much lower in cost because of the higher price of materials and labor and because of the larger and more difficult engineering and construction features which were not involved in the earlier projects. Such increases in project costs have, however, been accompanied by increasing values of farm production. This project will require the construction of a storage dam at the Hole-in-the-ground site 360 ft. in height, which is higher than the Arrowrock dam on the Boise project, now the highest dam on any reclammation project; and many miles of tunnels and high-head siphons.

"It is believed that with the favoring conditions of soil and climate and the excellent transportation facilities, since it is on a main line of a transcontinental railway, the Owyhee project is one of the desirable projects in this country, and when built will sustain a profitable agriculture, make prosperous homes for many of our citizens, and aid in the upbuilding of nearby towns."

Engineering Fifty Years Ago

From *Engineering News*, September, 1876

Hell Gate

THE great obstruction to ship navigation between New York and the Atlantic via Long Island Sound was successfully blown up on last Sunday, the 24th inst., at 2:51 p.m. A dull "thud" was heard, two quick, short pulsations were felt in the ground beneath, in a straight and narrow line from north to south of about 300 yard length, the water whitened and rose evenly three or four feet, then broke and spurted up about twelve feet high, in irregular, dark yellowish masses mixed with smoke, and fell back, and in a moment the river resumed its usual aspect. The work was done. The great crowds which had gathered in every available looking place sent up a cheer and the boats set out to pass over the place so recently a dangerous reef. The crowds went home, some simple ones disappointed that no buildings were shaken down, no glass broken and no tidal wave to sweep thousands from the docks, others to moralize on the moral turpitude of General Newton in making a gala day of the Sabbath, evidently thinking with William E. Dodge and some other good and well-meaning citizens of New York, that the success of an enterprise involving such a great expenditure of money and engineering ability, should be jeopardized by an unwarranted delay.

The work seems to have been well done and the reef thoroughly broken up. Unofficial soundings taken on Monday, give a least depth of 12 feet, and when the débris is removed, a clear channel will exist over the site of the reef of 26 feet at low water. The tidal run is much improved in the absence of the dangerous eddies.

The narrow channel now called Hell Gate (originally Whorl Gate and afterwards Hurl Gate) is off the Northwest corner of Long Island, in a formation of stratified gneiss. This channel is quite tortuous, in many places being obstructed and rendered dangerous by sharp isolated rocks in the channel way and submerged reefs making out from the shores. All these causes deflect and alter the tidal current, which here has a rapid run owing to the narrowness of the waterway, producing dangerous eddies or whorls, which apart from the submerged rocks, are quite dangerous to vessels, often throwing them powerless on the rocks.

$3,000,000 to Be Spent on Albany Terminal

Reconstruction of a considerable part of the union passenger terminal at Albany, N. Y., is to be undertaken in the near future, according to a report from that city. The estimated expenditure will amount to $3,000,000. The work will include the extension of the present high level yard out to the river front to provide additional passenger track facilities, replacing the present two-track approach bridge by a four-track bridge, enlargement of the building and alteration of the passenger passage-way.

It is also reported that the Delaware & Hudson Company is planning to go forward with work which was started in 1915, but never carried out on account of the war, for the construction of an elevated structure to bring its tracks into the union station.

Floods Continue to Do Damage in Central States

Intensive local rainfalls during a period of continued heavy rainfall were largely responsible for the recent floods throughout Illinois, but at several of the points of heaviest rainfall there were no rain gages. In the Illinois River the highest stage was about 3 ft. below that of 1922, and fortunately the Mississippi was low so that the floods had a free runoff. None of the levees on this river were broken, but there was emergency sand-bag work on some of them, especially at Beardstown, where they had not been kept up to standard level, which is 3 ft. above the 1922 flood line. On lands along this river the flood waters came from the hills and by seepage, so that great areas were submerged, and in some enclosed levee districts the pumping plants were of insufficient capacity to handle the water. Damage to crops was enormous. Several railway bridges, mostly trestles, were washed out, and highways under water were in some places damaged by scour. At Jacksonville, with a reported 8-in. rainfall, the dam of the water supply reservoir was carried away. This dam was about 600 ft. long, of earth construction, except for 150 ft. of concrete spillway at one end. Although this spillway was 4 ft. below the crest of the main dam, the water overtopped the latter by about a foot and carried out a large portion at the opposite end from the spillway. It is proposed to replace this with another 150-ft. concrete spillway. In some of the tributary streams the flood heights were greater than in the Illinois. The Sangamon River at Riverton reached a stage of 30.2 on Sept. 11, the highest since 1883, with a discharge of 27,000 c.f.s.; Spoon River at Seville, stage 26.8, discharge 19,500 c.f.s.; Crooked Creek at Ripley, 20.2 discharge 7,900 c.f.s.; and Mackinaw River near Green Valley, stage 10.4, discharge 7,400 c.f.s.

In Iowa and Kansas more floods have increased the damage reported earlier in the month. The report that the waterworks at Galesburg was put out of commission, published in our issue of Sept. 9 was in error.

Eight Dead Following Tunnel Explosion

New Kansas City Water Tunnel Heading Under Missouri River Wrecked —Committee Investigating

An explosion, which from the latest reports is believed to have resulted from infiltration of natural gas, occurred shortly after 5 a.m. September 15, in the heading of the 7½ ft. tunnel that is being built to bring water to Kansas City's distribution system from the new filtration plant in North Kansas City. The entire shift of eight men, in the tunnel at the time, was killed.

Because of the demolition of part of the ventilation system, allowing the tunnel to become saturated with the gas, and also on account of the wreckage of timber shoring and steel concrete forms, attempts to reach the heading were for a time unsuccessful, and the bodies of the men were not brought up until about 18 hr. after the explosion.

A committee of engineers has been appointed to investigate the explosion by H. F. McElroy, city manager. The members of the committee consist of N. T. Veatch, Jr., and Col. E. M. Stayton, engineers on the city's new sewerage system, and Matthew S. Murray, director of public works. The committee has visited the tunnel and questioned witnesses, but has not yet reported.

In a statement made to *Engineering News-Record* by Fuller & Maitland, the engineers in charge of the work, it is said: "The ventilating apparatus had been out of commission for several hours previous, and the men out of the tunnel. When the apparatus was repaired the men went in, and had barely reached the heading some 2,600 ft. away when the explosion occurred. How the gas became ignited is not known. About 2,000 ft. of the tunnel was concrete lined, and of the remaining 600 ft. some 300 ft. was timbered because of poor roof. Over 1,000 ft. of the ventilating pipe was blown down. All known precautions had been taken against gas explosions, such as, no smoking allowed, safety lamps, protective chamber for men during shooting, and firing by electric caps. Apparently the men entered too soon after the ventilating apparatus had resumed work, and before it had removed sufficient of the accumulated gas. Dynamite apparently played no part in the explosion, as an unexploded box of dynamite was found near the men. The men's bodies were intact, but burned on exposed portions."

The construction of this tunnel was described in *Engineering News-Record* April 8, 1926, page 573. It will be 15,500 ft. long, concrete lined, in shale and limestone 280 ft. below the general ground surface. It passes beneath the Missouri River, and across the bottom land to the new filtration plant now under construction.

Chas. S. Foreman, superintendent of construction for the contractor, Smith Brothers, Inc., Dallas, Tex., estimated the total damage to the tunnel and equipment at $10,000, a part of which was caused by damage to an electric locomotive. He said it would probably take ten days to clean the debris from the tunnel and repair it so that work could be resumed at a normal rate.

Jersey Approach Road Planned to Serve Bridge and Tunnel

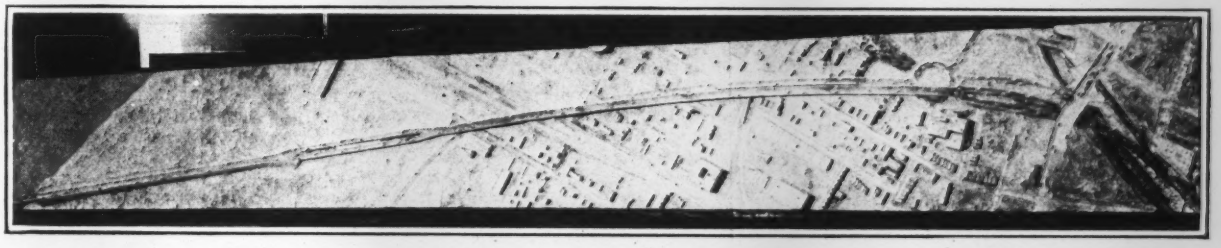
Planning of the Jersey City-Elizabeth approach road to the Holland tunnel through Jersey City and across the Hackensack meadows has been developed by arranging for traffic connections to serve also the Fort Lee bridge across the Hudson River (now being planned by the Port of New York Authority), and to make direct connections with the Lincoln Highway and with the Newark turnpike. The revised plan of the terminal section of the approach road, westward from the present end of construction on Bergen Hill to the Hackensack River, is shown in the accompanying plan photograph of a plaster model of the new location. This model was the means of laying the engineering plan before the State Highway Commission and the city authorities of Jersey City to obtain their approval.

As now planned the approach road, passing in subway under Hudson County Boulevard, on Jersey City Heights, soon emerges on fill and viaduct and continues on viaduct for the larger part of the distance to the Hackensack River, crossing over streets and railway tracks. At two points it divides to admit a central inclined approach, one for eastbound and one for westbound traffic flowing to the approach road from a new north-south thoroughfare extending along the west side of the Jersey City Heights slope. This north-south route, occupying Tonnele Ave., an existing street, is intended to constitute the principal southerly exit channel of the proposed Hudson River bridge from Fort Lee, N. J., to West 178th St., Manhattan. For the present it is to extend south to the Lincoln Highway, a mile south of the tunnel approach road, but it may later be extended to the Kill von Kull for connection with a future Bayonne-Staten Island bridge.

In order to make a traffic connection between the north-south road and the tunnel approach road, a round-point is provided in the north-south road, with separate radial approaches leading, respectively, eastward to the Hudson County Boulevard, southeastward to the eastbound incline leading up to the approach road, southward to the southerly extension of Tonnele Avenue (leading to the lower end of the Hudson County Boulevard), and westward to a separate road which is to be developed or improved through the western part of Jersey City, leading both to the westbound approach-road incline and to a new road extending southward along the edge of West Side Park, Jersey City, to a connection with the Lincoln Highway.

While the location and position of the Hackensack River crossing has not yet been definitely approved by the War Department, it is expected that this crossing and the location of the road embankment and viaduct west of the Hackensack will not be subject to much change. The Passaic River crossing, near the west end of the meadows, has already been fixed by War Department approval. The section of road just west of the Passaic River is now under construction.

The plans for the new road were worked out by the state highway department, W. G. Sloan, state highway engineer, through its Jersey City office, in charge of Fred Lavis.



PLASTER MODEL OF NEW JERSEY APPROACH TO VEHICULAR TUNNEL AT NEW YORK

Union Station for Lincoln, Neb.

After several years of discussion and negotiation over the project of a new union station at Lincoln, Neb., the Chicago, Burlington & Quincy R.R. has announced its intention of building a new station at a cost of about $1,000,000. Plans are being prepared and the company is arranging to move its local offices to temporary quarters.

Chicago Increases Engineers' Pay

As a sequel to the successful strike of engineers in city employ at Chicago last summer, the City Council on Sept. 15 approved a new salary schedule granting increased pay for engineering employees and also for certain positions in other departments where it is necessary to equalize salaries with those of the engineering department. Under this new schedule the city engineer will get $10,000 a year, an increase of $2,000; other increases range downward to $180 a year for the minor positions.

RANDOM LINES

Engineering As It Is

The "Hazardous Engineering Service, Inc.," has been incorporated in the State of New York. Judging from the experience of a good many who try to practice engineering the name might have universal appeal. Apparently what they are going to do, however, is to sell dying and cleaning concerns some machinery. And gasoline, when rubbed on cloth, is hazardous.

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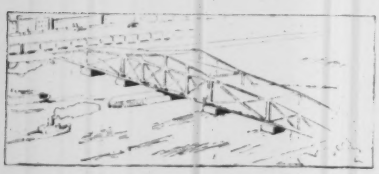
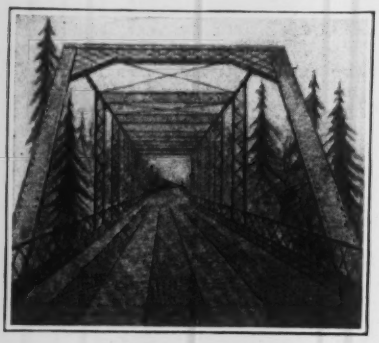
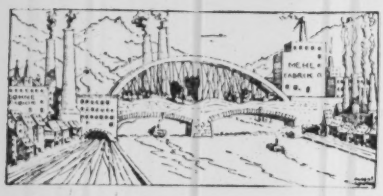
More Ad Men's Bridges







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Near the Two Hundred Mark

(194) *Idea Engineering* — What a pattern maker indulges in, according to the Kettlewell Co., of Detroit.

(195) *Vision Engineers*—Gentlemen of the Eyesight Conservation Council, according to the New York *Herald-Tribune.*

(196) *Ballistic Engineers* — People who design rifles, in the opinion of *Hunting and Fishing.*

(197) *Fish Screen Engineer* — Self explanatory cognomen of a chap in the Yakima Valley of Washington.

(198) *Lace Engineer* — A lady, this time who, says an article in *Management*, is "the hardest worked woman in seven counties." She washes lace curtains.

Plan for New Water Supply for Albany Adopted

Recommendations for Ultimate Gravity Supply of 70 M.G.D. Approved by Special Water Board

Recommendations for a new gravity water supply for Albany, N. Y., with an ultimate capacity of 70 m.g.d. in 1900, made by Robert E. Horton, consulting hydraulic engineer, Voorheesville, N. Y., were adopted on Sept. 14 by the Board of Water Supply, authorized by the 1926 legislature.

The plan is to store water in the Hannacrois and Catskill Creek drainage basins, which will be developed by stages. First, 30 m.g.d. from Hannacrois and Basic Creeks will be provided by a reservoid on the former, at Alcove, with a net available capacity of 4,400 m.g. A 59-ft. dam will flood 730 acres. From an aeration basin below the reservoir a 42-m.g.d. conduit about 20 miles long will lead to a new distributing reservoir in Albany. Later, an 8,000-m.g. reservoir, a little higher up, will be formed by a 74-ft. dam at Indian Fields, flooding 850 acres, with an aeration basin below it from which water may be sent into the Alcove reservoir or into the conduit just mentioned. Both dams will be on rock, with spillway overflow sections at the deeper parts, flanked with earth banks having core-walls. Basic Creek, a tributary of Catskill Creek, will be diverted into the Hannacrois Creek basin by a 2200-ft. tunnel, adding 16.37 miles to the tributary drainage area of 32.55 sq.mi. above the Alcove dam, making a total of nearly 50 sq.mi. in the Hannacrois-Basic Creek system.

FURTHER DEVELOPMENT

The second stage of the development will be to add 25 m.g.d., making a total of 55 m.g.d., by diverting still more water from the Catskill Creek drainage area, this time by means of two 55-ft. masonry dams on Catskill Creek, one at a point above Preston Hollow and one higher up, at Franklinton. The first of these will divert water through a 48-in. conduit to the head on a tributary of Hannacrois Creek, discharging into the Indian Fields reservoir. The upper dam will form a 300-m.g. reservoir, regulating the flow from 12.7 sq.mi. of gathering area. A second conduit to Albany with a capacity of 42 m.g.d., is planned as a part of the second stage of the development, which it is estimated will serve until 1980.

Stage three of the project, designed to bring the total safe yield to 70 m.g.d., and to give Albany all the water it needs until about the year 2000, would be consummated by raising the Preston Hollow dam, on Catskill Creek, and by diverting water from Ten Mile Creek.

The Hannacrois-Basic source was one of four possible sources named in a recent report by Nicholas S. Hill, New York City, before the creation of the special water board. Filtration is not proposed by Mr. Horton.

The members of the Albany Water Supply Board are Edwin Corning, chairman, Edward Easton, and J. Murray Prior, the latter being superintendent of the Albany Water-Works.

Admiral McGowan Resigns As Head of Commission

Rear Admiral Samuel McGowan (U. S. N. retired) resigned on September 16 as Chief State Commissioner of the South Carolina Highway Department, effective October 15. When Admiral McGowan accepted the post sixteen months ago he stipulated that he receive no salary in his position as Commissioner, a position for which the legislature provided $6,000 a year. Recently, however, the Highway Commission called upon him to accept pay for the entire period, stating that his gratuitous service might set a precedent which would be embarrassing to succeeding commissioners.

Fund of $15,000 a Year Provided for Municipal Research

The National Municipal League has received an allotment to enable the League to establish a department of research in administration in co-operation with the various local bureaus of municipal research of which there are now some forty in the United States. The new department will serve as a central clearing house on the subject indicated and will be under the supervision of a special committee composed of representatives of the National Municipal League and the Governmental Research Conference. The department began functioning Sept. 1. H. W. Dodds, 261 Broadway, New York City, is secretary of the National Municipal League.

New Bids Open for Reconstruction of High Bridge

Bids for the rebuilding of High Bridge over the Harlem River at New York City were opened by the Commission of Plants and Structures, City of New York, on September 16. The low bid was $1,190,300 by P. T. Cox Contracting Company. Bids ranged up to $1,427,450. The low bid is $291,100 lower than the low bid received last December on the method then proposed for reconstruction but it is still $90,300 more than the appropriation of the Board of Estimate.

Minneapolis Appoints Committee on Sewage Disposal

The sewage disposal problem confronting Minneapolis and St. Paul, already the subject of study by engineers of the Metropolitan Planning Association, is to be considered by the city of Minneapolis through a special commission of 11, consisting of 10 city officials and a representative of the University of Minnesota. The president of the commission is C. F. Keyes, chairman of the Minneapolis Board of Estimate. Financial questions are uppermost, reports state, it having been estimated by A. C. Godward, city planning engineer of Minneapolis, and other engineers of the association named above, that proper sewage disposal for the Twin Cities will cost $21,000,000.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., Oct. 11-14, 1926.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

THE ASPHALT ASSOCIATION, New York City; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

HIGHWAY RESEARCH BOARD, OF NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Dec. 2 and 3, 1926.

The Western States Convention of engineering societies, held at Denver, Colo., Sept. 20 to 23, included the western division of the American Mining Congress, the American Institute of Mining and Metallurgical Engineers, the American Association of Petroleum Geologists, the American Silver Producers' Association, and the western division of the American Mining Congress.

The Western Society of Engineers makes further announcements of its fall program, with certain changes, as follows: Sept. 27, "Flames of Atomic Hydrogen," Dr. Irving Langmuir; Oct. 4, "Water Softening for Boiler Feed Purposes," (three papers); Oct. 11, "Air Conditioning and Refrigeration; Oct. 18, "Filtration of Municipal Water Supplies," George H. Fenkell, Detroit; Oct. 25, "The New Talking-Movie Picture"; Nov. 1, "The Optics of Illumination," on the effect of illumination upon the eyes; Nov. 8, "Steel Structural Design of the Stevens Hotel," Frank E. Brown. Excursions are planned to the electrified lines of the Illinois Central R.R. on Sept. 25 and to the Allis-Chalmers plant at Milwaukee on Oct. 8.

The American Society of Safety Engineers, whose membership comprises what is known as the Engineering Section of the National Safety Council, will hold its 15th annual convention at Detroit, Oct. 25-29. Men from the construction industry who will address the meeting include Dr. Neal Harris, president, Toledo Chapter, A.G.C.; W. L. Chewning, vice-president, U.G.I. Contracting Co.; Otto Misch, president, Detroit General Builders Association; W. S. Smith, of the Mutual Liability Co.; Stanley Eigel, of the Milwaukee Chapter, A.G.C., and D. F. McMurchy, of the Ohio Industrial Commission.

The Assocation of Highway Officials of the North Atlantic States will hold its third annual convention at Atlantic City, N. J., Feb. 16 to 18, 1927.

The Highway Research Board, of the National Research Council, will hold its annual meeting in Washington, D. C., Dec. 2 and 3, 1926.

Personal Notes

P. K. SCHUYLER has resigned as senior bridge engineer of the Comisión Nacional de Camínos in Mexico City and Sam Wright, formerly with the Southern Pacific R.R., has been appointed to this position. Mr. Schuyler will be connected with the Bureau of Public Roads in Washington, D. C., in the position of associate highway bridge engineer.

CAPT. G. A. MCKAY, (CEC) U. S. Navy, is being detached as assistant chief of the Bureau of Yards and Docks and will assume duty as public works officer of the Naval Operating Base at San Diego, Calif. He will be relieved as assistant chief by CAPT. PAUL L. REED (CEC), U. S. Navy, who has recently been on duty at the Naval Operating Base, Hampton Roads, Va. CAPT. ERNEST R. GAYLER (CEC), U. S. Navy, is being transferred from duty in the Bureau and will relieve CAPT. WALTER H. ALLEN, (CEC) U. S. Navy, as public works officer of the Navy Yard, Puget Sound, Wash., and Thirteenth Naval District. Captain Allen is being transferred as public works officer of the Naval Operating Base at Hampton Roads, Va. CAPT. DEWITT C. WEBB, (CEC) U. S. Navy, now on duty at San Diego, will go to Washington as head of the design division of the Bureau of Yards and Docks.

THOMAS C. DESMOND, president of the T. C. Desmond Company, Inc., New York, has left for Europe to study workingmen's housing developments in Germany and Holland. Last year Mr. Desmond served on the sub-committee of housing which assisted in the drafting of the housing bill passed by the New York State Legislature.

N. T. BOURKE, of the University of Arkansas, has been appointed professor of mechanical engineering at the University of North Dakota, succeeding GEORGE B. WHAREN, who died in May, 1926.

W. A. OLIVER, who has been employed as structural engineer in the office of the state architect and engineer, Columbus, Ohio, has accepted position as structural engineer with Orbison & Orbison, consulting engineers, Appleton, Wis.

E. F. CHANDLER, professor of civil engineering at the University of North Dakota, University Station, N. D., has been appointed dean of the College of Engineering and School of Mines. He has been acting dean since the sudden death of E. J. Babcock in September, 1925. Mr. Chandler has been a member of the faculty for 27 years and has been in charge of the civil engineering course since 1910. He was also the first state engineer of North Dakota, 1904-1905. As hydraulic engineer of the U. S. Geological Survey he has had supervision of river-station work and flood records through North Dakota and adjoining territory since 1903, and he is engaged in much of the engineering development of that region.

Prof. HENRY B. ALVORD, in charge of the department of civil engineering at Northeastern University, Boston, was engaged as consulting engineer during the summer in making a triangulation survey in the Cascade Range in Washington for the Great Northern Railway Co. in connection with the construction of its new eight-mile tunnel. The purpose of the survey was to provide a check on the open traverse previously run, on which construction has been based since last December.

Obituary

COLONEL C. W. P. RAMSAY, of Montreal, died Sept. 10 as the result of an accident received while driving on the east Stanbridge highway near Bedford, Que., when his car overturned. Colonel Ramsay was born in Bury, Que., and was 43 years of age. He began his active career as a civil engineer in the construction department of the Canadian Pacific Ry. on the construction of the line between Montreal and Toronto. Subsequently he became engineer of construction in charge of all new construction on the Eastern Lines. When the War broke out he organized the Canadian Overseas Construcuion Corps and rendered exceptional service in France, for which he was made a Companion of St. Michael and St. George and was awarded the Distinguished Service Cross. Shortly after the War he went into business with the Grenville Crushed Rock Co. at Montreal.

NATHAN G. BAGLEY, of Wheatland, Wyo., who died Aug. 18, was senior member of the contracting firm of Bagley Brothers, which has done a large amount of highway construction in Wyoming.

JUDSON E. HOYT, engineer for the state of Wisconsin in charge of construction of public buildings, died at Madison, Wis., September 6.

CHARLES G. ELLIOTT, Washington, D. C., civil engineer and for many years expert on farm land drainage for the United States Department of Agriculture, died Sept. 14 at his home in Washington, aged 76 years. Mr. Elliott was in the service of the department from 1902 to 1913 on drainage at experimental stations and on western irrigation, and then became a member of the engineering firm of Elliott & Harman with offices at Peoria, Ill., Memphis, Tenn., and Washington. He was a civil engineering graduate of the University of Illinois and author of articles on drainage and irrigation, and for a time editor of *Drainage Journal*.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Pipe Lining Field Entered by Steel Corporation

Acquisition by the U. S. Steel Corp. of American rights in a British method of lining steel and cast-iron pipes, called the Talbot method, was informally announced at the Providence convention of the American Water Works Association last week. A compound of 32 per cent bitumen and 68 per cent "ground rock" is spun into place as an interior lining and the same material is or may be pressed on the exterior as a protective coating. The process is covered by U. S. Patent No. 1,555,257. Heretofore it has been promoted in this country by the Talbot Non-Corrosive Linings Co., Widener Building, Philadelphia. A trade catalogue issued by the company just named lists 18 British cities that have installed pipe with the Talbot lining, including London, Birmingham and Glasgow, and states that it is also used in Australia, Argentine and four other non-European countries.

Concrete Road Yardage

For August the square yardage included in concrete pavement contract awards, according to the Portland Cement Association, were: 6,594,150 for roads; 6,293,849 for streets; and 360,991 for alleys; or a total for the month of 13,248,990. sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1926

Month	Roads	Streets	Alleys	Total All Classes
Jan.....	2,161,415	1,410,201	57,218	3,628,834
Feb.....	2,726,611	2,010,941	274,836	5,012,388
March..	4,662,885	3,050,630	224,879	7,938,394
April....	8,758,195	4,324,729	479,763	13,562,687
May....	8,910,678	4,619,195	507,250	14,037,123
June....	10,793,452	5,999,859	524,572	17,317,883
July....	5,662,841	4,865,421	327,313	10,855,576
Aug....	6,594,150	6,293,849	360,991	13,248,990
Total.	50,270,227	32,574,825	2,756,822	85,601,874

Free Trip Offered to 1927 Road Show in Chicago

The American Road Builders' Association will give a free trip to the 1927 convention and road show in Chicago to the engineer who writes the best article describing a method material or equipment and its application to the construction, maintenance, or operation of highways. In addition to the first prize, which consists of traveling expenses to and from Chicago and hotel expenses during Jan. 11, 12 and 13, there are offered second and third cash prizes of $150 and $75 respectively.

Any engineer of the rank of inspector, rodman or above, except State Highway engineer may be eligible if he is connected with a city, county or state highway organization. Award will be made on the subject and on the manner in which it is presented. The article is limited to 1,500 words, typewritten on one side of paper only. It must be in the hands of Chas. M. Upham, business director, American Road Builders' Association, Box 1270, Raleigh, N. C. The judges will be the executive committee of the association and the Highway Industries Association.

Patent for Belt Finishing of Concrete Roads Upheld

Although the patent allowed for the use of a belt in finishing concrete roads contemplated hand manipulation, the use of a belt on mechanical finishing machines has been held to be an infringement of the original patent by the district court, Eastern District of Michigan. The suit in question was brought by George C. Walker and Thomas M. Lucking against the Lakewood Engineering Co. and Edward C. Carr.

In the court's statement it is said that "It is not these great complex machines that necessarily disclose patentability and ingenuity. What we really intend by the patent law is to reward by the grant of a monopoly the bringing forth of something that can be used to our advantage which had not been thought of before. There is nothing that the defendant's belt does that was not done by the hand belt. I think this is a broad patent. Do not get the notion that it has to be limited to the form which is shown in his drawing. I do not think anybody can use a belt, reciprocating across the surface of the road, without infringing this patent. They can improve on it; they can make other inventions, but I think if they use the strap they must pay tribute to Walker." The opinion was given by Judge Tuttle Aug. 10, 1926, together with an order for the payment of the usual damages and profits.

Corrugated Iron Culverts Are Thirty Years Old

The corrugated iron culvert was invented thirty years ago in Crawfordsville, Ind., by James H. Watson, a sheet steel manufacturer, and a 15-page booklet has recently been published by the Armco Culvert and Flume Manufacturers' Association, Middletown, Ohio, commemorating this event. It is said in the book that the idea was conceived by Stanley Simpson, then city engineer of Crawfordsville, as he observed a druggist packing some prescriptions in corrugated cardboard containers. He consulted Watson, and together they worked out the idea. The first corrugations were placed lengthwise of the pipe but the patent was taken out on circumferential corrugations as now used. It is significant to note that in the thirty years it has not been found necessary to alter in any way Watson's original design. The third important personality who helped to pioneer the corrugated iron culvert was W. Q. O'Neall, a road superintendent and agriculturist who watched Watson's experiment and in 1903 and 1904 respectively bought Watson's and Simpson's interest in the patent and business. It was O'Neall who placed the business on a sound basis and established factories in many states. The manufacture of the iron for these corrugated culverts was taken over in 1906 by the American Rolling Mill Co., at Middletown, Ohio, which company was then only about five years old. The association of manufacturers and the rolling mill have been actively engaged in production, research and tests since that time.

The booklet reviews the history of the corrugated iron culvert in detail.

Business Notes

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., recently reorganized its general engineering department. Four of the engineers have been promoted to managers of engineering. These are F. C. Hanker, manager, central station engineering; S. B. Cooper, manager, railway engineering; G. E. Stoltz, manager, industrial engineering, and W. E. Thau, manager, marine engineering. S. A. Staege has been appointed industrial engineer giving particular attention to the paper mill industry. Other appointments announced are: For Central station engineering, C. A. Powell, generating station engineering, R. D. Evans, transmission engineering, and C. A. Butcher, substation engineering; for railway engineering, H. K. Smith, heavy traction engineering; G. M. Woods, light traction engineering, and A. H. Candee, gas-electric traction engineering. N. W. Storer has been appointed consulting railway engineer in charge of Diesel-electric locomotives and rail cars.

MORRISON & RISMAN CO., INC., Buffalo, N. Y., announces that it will furnish all railroad track material used in the construction of the 9½ miles of railroad track which is to be placed at the Pontiac Motor Car Co.'s plant at Pontiac, Mich.

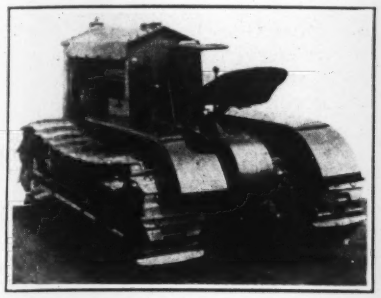
New Developments

Heavy-Duty Tractor Has Important Features

Supplementing its Model K four-cylinder tractor, the Cleveland Tractor Co., Cleveland, Ohio, has just announced a Model A six-cylinder 30-45 hp. crawler-mounted heavy-duty tractor. Special features on this new machine are the automatic oiling system also

used on the Model K and the utilization of all power developed by the engine. The "Snap" oiling system is used which by the push of a plunger on the dashboard oils all but four of the points requiring "hard oil." There are only four grease cups on the tractor. Dustproof construction protects all the driving parts.

There are 1,800 sq.in. of ground con-

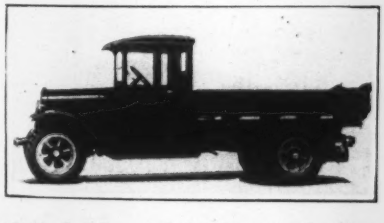


tact which is said to transmit to the drawbar the full pulling power developed by the motor. In steering the tractor, no power is wasted due to stopping one of the tracks. When it is desired to turn the inside track is slowed down and the outside track speeded up by action of the steering wheel which is of the automobile type.

The engine is watercooled and uses 4x5-in. cylinders. A gasoline tank of 22 gal. is provided with an auxiliary tank of ¾ gal. The overall dimensions are 109 in. long, 57 in. wide, and 63 in. high. Center to center of tracks is 44 in. Track shoes are 13 in. wide and use 25 manganese steel shoes for each track. Detachable grouters 2⅛ in. high and 16 in. wide are provided. The low speed is 2½ m.p.h., while 4.75 m.p.h. is attained at high speed. A reverse speed of 1.8 m.p.h. is available. Drawbar pulls are 5,700 lb. at 2.5 m.p.h. and 3,500 lb. at 4.75 m.p.h. Ratings are 30 hp. at the drawbar and 45 hp. at the pulley.

Two-Ton Truck Added to Line of Smaller Capacities

The latest additions to the line of commercial cars and trucks manufactured by Graham Brothers, Detroit, and sold by Dodge Brothers, dealers, are two new types of two-ton capacity. A number of bodies suited to practically all requirements are available. The two types differ mainly in length, one being for 9 ft. bodies and having a wheelbase of 137 in. and the other for

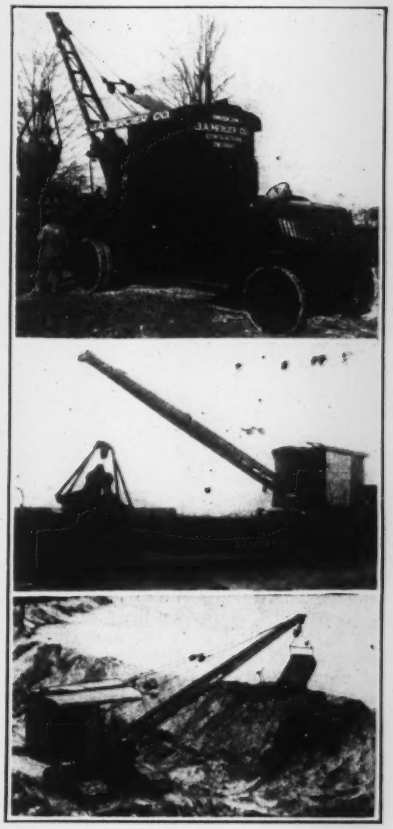


12-ft. bodies and having a wheelbase of 162 in. Both chassis are equipped only with pneumatic tires, either single or dual rears optional. The side frames are 7 and 7⅛ in. deep respectively. Front springs on both chassis are 37 in. long, while the rear springs are 56 in. long. The semi-floating rear axles employ a spiral bevel gear final drive with a reduction of 6.286 to 1.

The brakes are so connected that the pedal operates four bands, all on the rear wheels, while the brake lever actuates only two. This feature, it is declared, insures long life and even wear of the brake facings. The power unit consists of the Dodge Brothers four-cylinder engine.

Truck Crane Transferable to Various Mountings

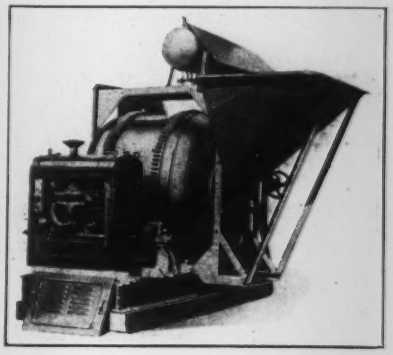
Although built as a standard machine, the truck cranes manufactured by the Universal Crane Co., Cleveland, Ohio, are designed for practically every job condition by being made adaptable to various mountings. The crane is merely lifted from one mounting and transferred to the other without extensive machinery changes, new parts, etc.



There are six standard mountings, three of which are shown in the illustrations. At the top is the conventional mounting on the rear of a motor truck used when speedy mobility is desired. In the center is shown a railroad mounting as used by the D. T. & I. R.R., Pennsylvania R.R., Pere Marquette, New York Central, etc. At the bottom the unit is shown mounted on crawlers. The crawlers shown are wider than standard on account of the soft ground conditions existing. The other three mountings consist of a heavy-duty trailer, steel wheel industrial truck, and a portable mounting.

New Power Unit on Large Mixer

The mixer illustrated is the 28-S machine manufactured by the Koehring Co., Milwaukee, Wis., which has recently been equipped with a Waukesha



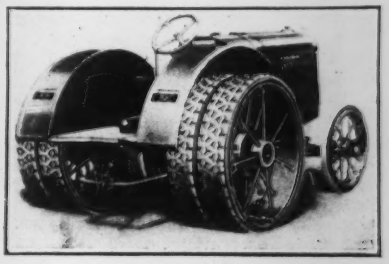
power unit. This unit consists of a four-cylinder, 4x5, 900-r.p.m. gasoline engine, gasoline tank and radiator mounted in a steel frame. This same power unit has also been adopted for the company's 21-S mixers.

New Steel Tractor Wheels for Largest Size Rubber Tires

The largest solid rubber tires used on tractors are said to be 50 in. in diam. by 10 in. wide. French & Hecht, Davenport, Iowa, has recently developed a built up steel expansion wheel for using these tires. The development of the tires was brought about by the wheel makers in co-operation with the rubber tire manufacturers. It is said that tires of this diameter have been used before but not in this extreme width and made up in one continuous ring of rubber. The new wheels were originally designed for and are now used on the McCormick-Deering 15-30 tractor. The rubber tires are the same type used on motor truck service in that the rubber is vulcanized on the channel steel base.

A noteworthy feature of the wheels is that no power press is required to mount or remove the large rubber tires. Expanding wedges in the steel rims make it possible with the use of a heavy hammer and an ordinary wrench to change tires.

Another special feature in the design of the expansion wheels makes it possible to add extension wheels that provide either three 50x5 in. triple rubber tires giving a road contact of 15 in. wide, or two 50x10 in. tires making a 20 in. face for each wheel. Attachment between the extension wheel and the main wheel is by means of six bolts at



the rim and seven at the hub. This arrangement is shown in the illustration where two tires 10 in. wide are used. The outer end of the main wheel hub is machined to fit into a machined recess in the extension wheel hub. Standard French & Hecht construction is used, the wheel spokes being formed by special machinery which upsets a head on the inside and a shoulder on the outside of the hub. The main wheel proper without the rubber tire is 44 in. in diameter and has 29-1 in. round spokes, while the extension wheel has 16-1 in. round spokes. The front wheels are also of the expansion type and use 34 in. diam. by 5 in. wide solid rubber tires.

New Publications

Sanitary Sewers.—W. F. DICKEY CLAY MANUFACTURING CO., Kansas City, Mo., has issued a book of 160 pages devoted to the use of sanitary sewers in the cities. Besides technical data, which include descriptions of the company's clay pipes on many installations together with graphs for earth load fills, velocities, and discharge, about half of the book is devoted to exposition of the desirability of better sanitary conditions in many localities. Many testimonial letters are reproduced showing the long life of a variety of the company's installations. It is especially well illustrated and contains a number of practical hints for installing vitrified clay pipe lines.

Concrete Masonry Construction—PORTLAND CEMENT ASSOCIATION, Chicago, has issued a 50-page book on concrete masory construction, including among other things about 20 pages of construction details for using concrete blocks, for pouring solid slab floors, for building concrete block-wall and tile-wall sections, beams, chimneys, etc. In addition, the text gives much information on masonry construction as used in buildings and homes, both as a finished construction in itself and as a base for stucco finish. The last ten pages of the booklet are devoted to specifications and suggested and recommended building ordinances.

Skylights—H. H. ROBERTSON CO., Pittsburgh, has issued a leaflet describing its unit skylights, comprising a standardized line of double-pitch and hip skylights in standard widths of 3 to 20 ft. and in any length desired. Blueprint details, photographs and descriptions are used in the 8-page leaflet.

Motor Trucks—WALTER MOTOR TRUCK CO., INC., Queens Boulevard at 37th St., Long Island City, New York, has made available a catalog describing its four-wheel drive and four-wheel brake tractor-trucks. The principles of construction are illustrated and described and illustrations, together with line cut drawings, give all essential details and information concerning the units. The trucks feature uses with many types of trailers.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Sept. 23, 1926	$20,896,000	$30,786,000	$51,682,000
Sept. 16, 1926	20,307,000	33,648,000	53,955,000
Sept. 24, 1925	24,934,000	17,918,000	42,852,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	829,343,000	1,290,671,000	2,120,014,000
1925	803,104,000	1,051,526,000	1,854,630,000

Production Statistics Indicate Price Firmness In Basic Materials

Brick and Cement Will Probably Hold at Present Levels—Lumber Advancing—Steel Output Gains While Orders Drop

AN UPWARD tendency in the price of lumber, firmness at present levels in brick and cement, and slight possibilities of further advance in steel, in the immediate future, are indicated by latest statistics covering production, shipments, demand and reserve stocks in these four basic materials.

To begin with, softwood lumber produced by the seven regional divisions of the National Lumber Manufacturers' Association, during the first thirty-six weeks of 1926, showed a drop of 0.2 per cent as compared with the same period last year. This small decrease in output was greatly outweighed by an increase of 3 per cent in shipments and 5 per cent in new orders, comparing the corresponding months. At the present rate of depletion, smaller reserve stocks will shortly justify higher price quotations.

Following are the figures for the first thirty-six weeks of this year, compared with last:

	Production Ft. b.m.	Shipments Ft. b.m.	Orders Ft. b.m.
1926	8,560,800,078	8,762,815,511	8,786,538,983
1925	8,583,396,948	8,530,821,046	8,404,592,375

Brick reports compiled by the Common Brick Manufacturers' Association of America, show 13 per cent more burned brick on hand at yards, with a 6 per cent decrease in shipments. This increase in the available supply is met by a 6 per cent gain in unfilled orders, with the result that prices will probably fluctuate little from present levels, for some weeks to come. Following are latest data on the common brick movement throughout the country:

	Burned Brick on Hand M	Brick Moved from Yards During Month M	Orders on Books M
Aug. 1, 1926	218,348	140,623	234,164
July 1, 1926	193,246	149,170	220,078
Aug. 1, 1925	227,306	180,407	292,775

Cement will probably continue to retain its customary price stability, according to figures submitted by the Bureau of Mines. August production for all of the nations mills, dropped 0.5 per cent, compared with the month preceding. During the same period shipments (demand) declined 1 per cent and reserve mill stocks 9 per cent. The balancing of output with demand in this case, insures that stability in cement quotations, so noticeable during the past three years or more. Following figures show the cement mill situation throughout the country:

	Production Thousand Barrels		Shipments Thousand Barrels		Stocks at End of Month Thousand Barrels	
	1925	1926	1925	1926	1925	1926
First Quarter	28,145	25,973	21,456	21,031	20,469	23,200
Second Quarter	44,697	45,700	48,630	50,025	16,409	18,900
July	15,641	17,096	18,131	18,786	13,896	17,210
August	16,419	16,936	18,383	18,536	11,952	15,610

Steel ingot output for August was 10 per cent greater than that for the month preceding according to reports of the American Iron and Steel Institute. Unfilled orders on books of the United States Steel Corporation, Aug. 31, were

(*Continued on p. 525*)

Production Statistics Indicate Price Firmness

(*Continued from p. 524*)

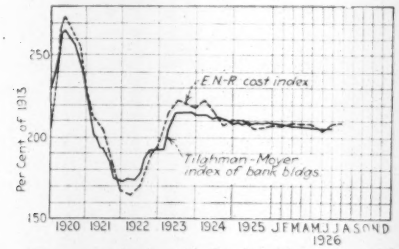
2 per cent below those on hand July 31, 1926. An increase in the steel ingot output in the face of decreased demand will assuredly not influence prices in an upward direction. Following are ingot output figures compared with the unfilled steel tonnage:

	Ingot Production All Companies Tons	*Orders on Books U. S. Steel Corp. Tons
August, 1926	4,004,583	3,542,335
July, 1926	3,651,055	3,602,522
August, 1925	3,420,998	3,512,803

* On last day of each month.

Cost of Banks Compared with General Construction Costs

An index number showing cost of building banks in the Eastern states, compiled by the Tilghman Moyer Co., architects and engineers, Allentown, Pa., is here compared with the *Engineering News-Record* Construction Cost Index Number, which covers general costs or for the country as a whole.


E.N-R cost index
Tilghman-Moyer index of bank bldgs.
Per Cent of 1913
250
200
150
1920 1921 1922 1923 1924 1925 J F M A M J J A S O N D
1926

The marked similarity in general characteristics of the two curves, since the peak year 1920, is all the more noticeable because of the fact that in the former a particular type of building in a particular section is involved, whereas the latter is a composite of national cost factors,

This Week's Special Tabulation of Unit Prices

Steel Pipe Piling

The following unit prices are included in the low bidders' estimates on Philadelphia subway contracts covering 12-in. steel pipe piling, awarded during 1924 and 1925:

Date	Vertical Ft.	Price per Vert. Ft.
August, 1924	50	$8.00
October, 1924	100	8.00
November, 1924	100	8.00
March, 1925	100	10.00
August, 1925	100	10.00
September, 1925	100	7.50

Next week—Sept. 30

Analysis of 13 years' road lettings—thorough statistical study of trends—close adherence to estimated normal since 1920 — contract values predicted for last quarter of 1926.

New England Water-Works Construction Active

Contract Letting Jan. 1 to Date Already 30 Per Cent Ahead of 1925 Total For This Class In This Section

A SUM exceeding $25,000,000 has been expended for water-works projects of considerable size, throughout the New England states, during the last thirteen years. These jobs include all contracts valued at $15,000 and over as reported in the Construction News section of *Engineering News-Record.*

Contracts for water-works construction, awarded at the minimum mentioned, in this section, for the first eight months of the current year, amounted to $2,859,000 or 30 per cent ahead of the total for the entire year 1925 in the New England states. The eight-months total, this year, is also 38 per cent greater than that for the corresponding period in 1925.

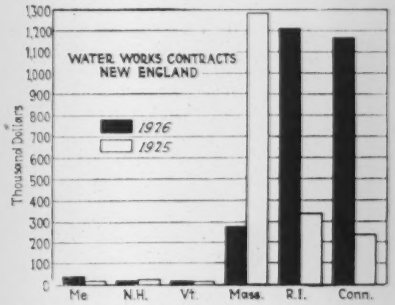
This year, as during last, the activity is largely within the states of Rhode Island, Connecticut, and Massachusetts, with the smallest volume awarded in Vermont.

In money value of contracts let for this class during the period Jan. 1 to Sept. 1, 1926, Maine more than doubled its total for the corresponding months last year. Rhode Island's volume was three times and that of Connecticut, five times the 1925 water-works lettings for the first eight months.

Following are the yearly totals of water-works awards for the New England section at a minimum value of $15,000:

1913	$2,006,000	1920	$673,000
1914	2,606,000	1921	4,618,000
1915	1,486,000	1922	2,270,000
1916	912,000	1923	947,000
1917	825,000	1924	4,284,000
1918	1,039,000	1925	2,203,000
1919	1,040,000	1926*	2,859,000

* First eight months.



AWARDS FOR PERIOD JAN. 1 TO AUG. 1

Sharp Drop In Iron and Steel Imports—C.-I. Pipe Receipts Continue Heavy

A DECLINE of over 33 per cent in imports of iron and steel products into the United States during July as compared with the month preceding, may indicate a turn in the tide of competition, recently encountered by domestic producers of pig-iron, steel rails, scrap, steel bars, ferro-manganese, and structural shapes.

July is the latest month for which figures are available and the following, issued by the Iron and Steel Division of the U. S. Department of Commerce, show the situation as related to imports and exports of products in this class:

Month	Exports Gross Tons	Imports Gross Tons
July	194,717	82,411
June	159,506	124,215
First Seven Months	**Exports Gross Tons**	**Imports Gross Tons**
1926	1,223,300	695,380
1925	982,156	556,353

The nations to which the United States exported iron and steel products during July, in order of importance, are as follows:

Country	Per Cent of Total July Exports
Canada	40.0
Japan	13.0
Mexico	5.5
Philippine Islands	4.4
Cuba	4.0
Venezuela	3.7

The gain in July exports was marked by an approximate increase of 300 per cent in ingots, blooms and skelp, combined. Boiler tubes gained 54 per cent; tin plates, 58 per cent; black steel sheets, 50 per cent; and steel rails, 40 per cent. Exports decreased, during July, to the extent of 22 per cent in structural shapes; 27 per cent in scrap; 23 per cent in steel plates; and 93 per cent in cast-iron pressure pipe and fittings.

The substantial excess of exports over imports in this class and the present downward tendency in imports, do not obscure the fact that during July, receipts of cast-iron pipe increased 3,300 tons and all other pipe tubes, 3,000 tons.

The seven principal nations from which iron and steel products were received during July, in order of importance, are as follows:

Country	Per Cent of Total July Imports
Germany	29.2
Belgium	20.8
France	14.7
United Kingdom	11.7
Canada	7.0
Netherlands	6.6
India	5.9

The relation of the principal products to the total July imports from each nation, follows:

Country	Product	Per Cent of Imports from Individual Nation
Germany	Pig iron	40
	Steel bars	10
	Steel shapes	10
	Steel rails	10
	Steel pipe	15
Belgium	Steel shapes	50
	Steel bars	25
	Pipe	15
France	C.-I. pipe	60
	Pig iron	15
	Steel bars	10
United Kingdom	Pig iron	90
Canada	Scrap	50
Netherlands	Pig iron	over 50
India	Pig iron	over 50

Weekly Construction Market

ENGINEERING construction contracts awarded in the U. S., Jan. 1 to Sept. 1, 1926, exceeded by 19 per cent, in total money value, the corresponding months last year. Projected work for the same period gained 16 per cent.

Building permits during the same period, however, dropped approximately 6 per cent. This is in marked contrast with the gain in contract letting which showed up heavier in buildings than in other forms of construction.

The drop in permits possibly indicates a decline in building awards in the not distant future but the present large volume of building contracts is obviously responsible for the firmness existing in current materials prices. The general price level for the entire country, so far as construction materials are concerned, has been mounting gradually since July.

Steel quotations, structurals particularly, have remained steady for the last three months or more. Brick and other building materials show firmness with an upward tendency which started back in June.

Lumber appears steadier, compared with a few weeks ago. After a protracted decline, beginning in February of this year, the situation in yellow pine is greatly improved. Hardwood prices are gaining in firmness, slowly but steadily.

Labor costs in the construction industry hold at August levels. Building trades strikes of importance now number but little more than half those in effect a month ago.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montrea
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb.	4.20	3.80	—4.65	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	3.38	2.60	2.87½	3.77½	2.95	3.25	2.50
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	—54%	51%	54.25%—41%		35.6@49.2%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	52.60@53.60	45.25	54.00	49.20@50.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	—2.35	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd.	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.00	34.00	56.00	40.50	38.25	34.75	27.00	23.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	+20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.50	+1.85	2.25	1.60@1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.075	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.075	.076	.075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	+ .87¾	.99¾	+1.18	—.90	—.96¾	—1.10	1.04	1.12	1.03
Common Labor									
Common labor, union, hour	.90⅜	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.45@.60	40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Sept. 2 the next on Oct. 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.156). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, less-than-carload lots.

Business Briefs

Call money quoted at 5½ per cent, Sept. 21; year ago 4½ per cent.

Time loans: Sixty-ninety days, 4⅞; four-six months, 5 per cent.

Commercial paper: Best names, 4½ per cent; other names, 4¾ per cent.

On Sept. 1, 1926

E. N.-R. Construction Cost Index Number 208.30

E. N.-R. Construction Volume Index Number 252

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month